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# Engineering News-Record

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July 13, 1933

## Non-Slip Hydraulic-Fill Dam for San Diego

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## Composite Piles for Neuces River Bridge

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## Building a Steel Shelter for the Casa Grande Ruins

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## Vermont-New Hampshire Boundary Fixed by U. S. Supreme Court

◆

## Analysis of Highway Earnings

*Concluding Article of a Series on How the Highway Pays*

◆

## Hydraulic Phenomena Studied With Models

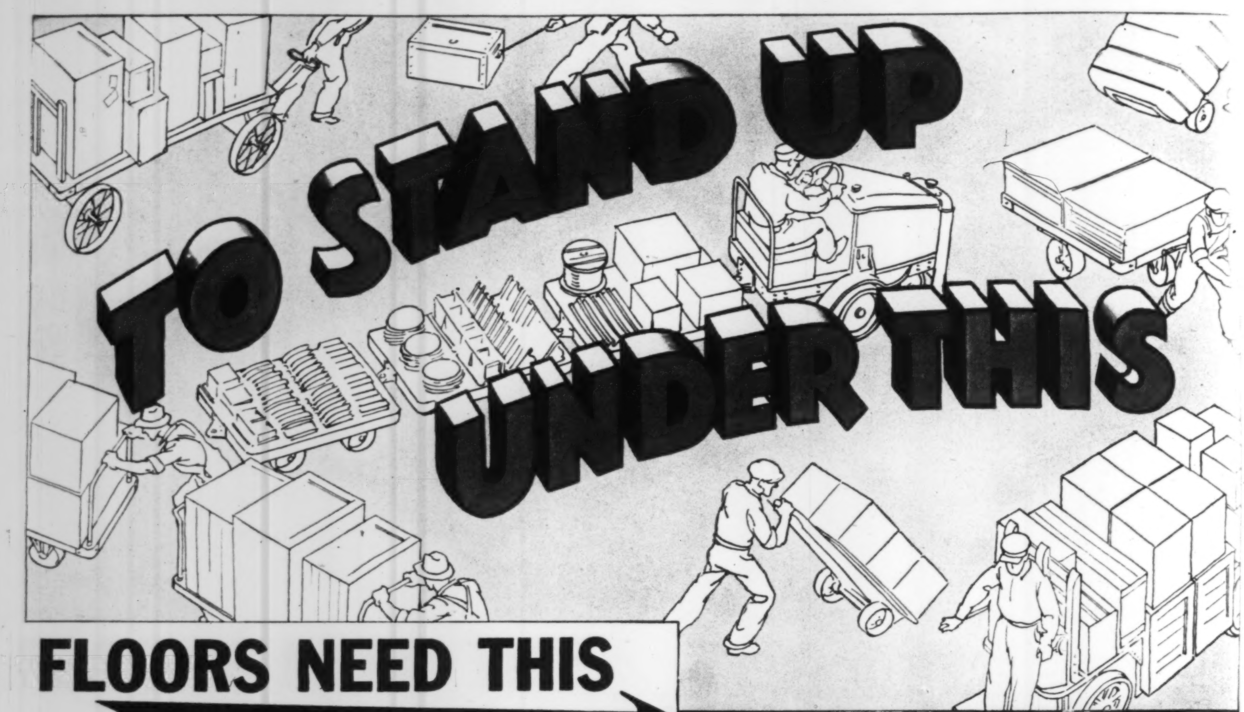
*Fourth of a Series of Articles on the Mississippi River*

CONVENTION

REPORTS:

*American Society of Civil Engineers*

*American Society for Testing Materials*



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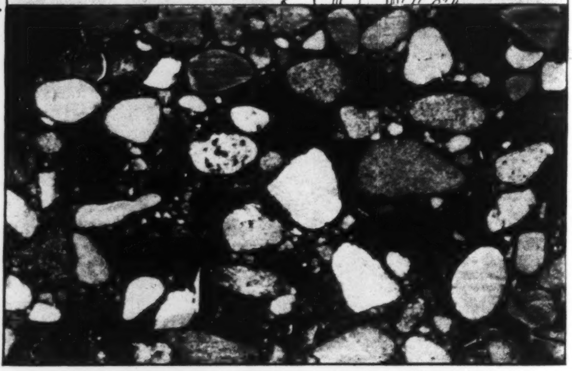

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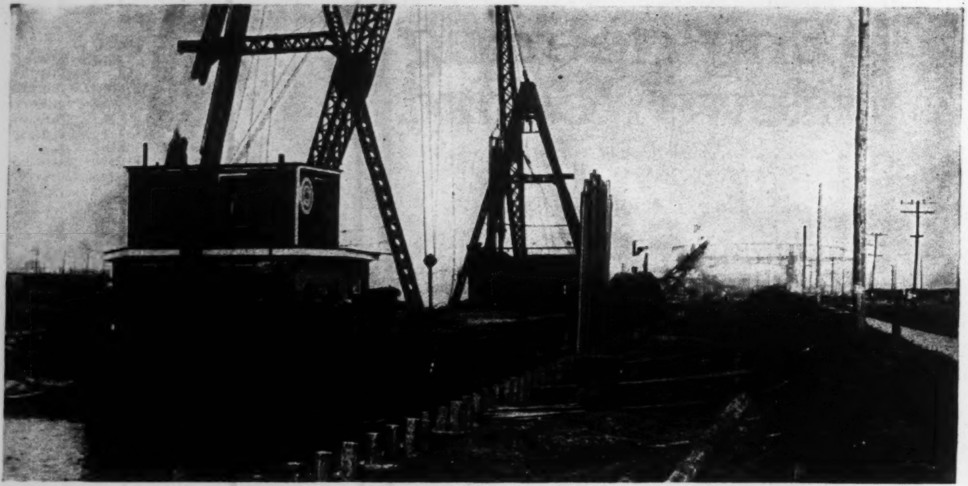

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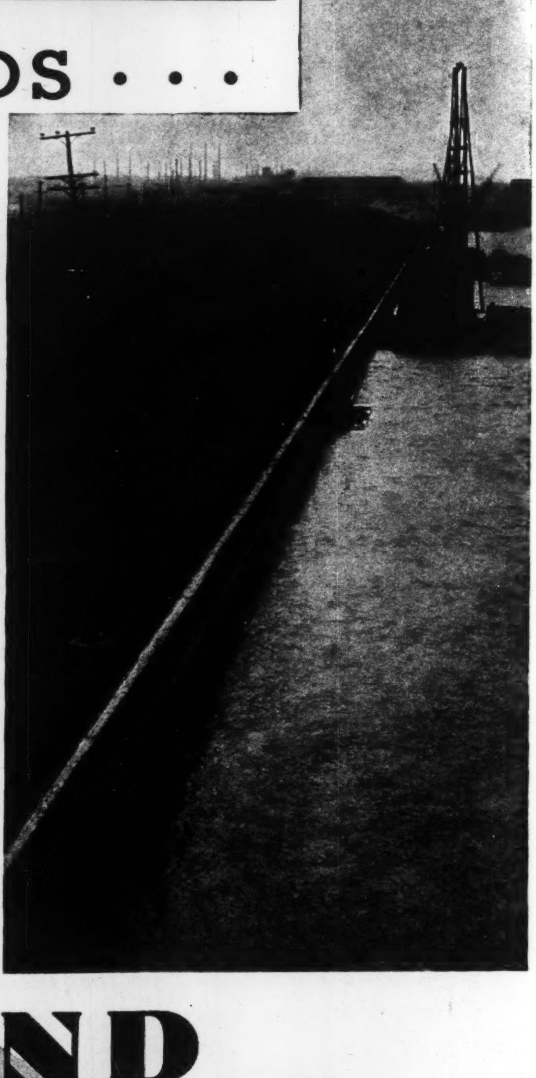

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# Non-Slip Hydraulic-Fill Dam for San Diego

### Slip and spread of semi-hydraulic fill in El Capitan Dam is restrained by concrete toewalls and heavy armoring of riprap—Downstream drainage tunnels provided

By H. N. Savage
*Hydraulic Engineer in Charge,*
*Bureau of Water Development, San Diego, Calif.*

To AUGMENT the municipal water supply of San Diego, Calif., by about 70 per cent, the city is constructing the El Capitan Dam on the San Diego River and will complete the project by building an 8-mile pipe line to convey this supply to the existing system. The dam is a hydraulic-fill and rock-embankment structure 217 ft. high above streambed with a 53-ft. depth of cutoff wall, 1,200 ft. long at the crest, and has side slopes varying from 1:1.5 to 1:3, providing a maximum thickness of 1,240 ft. at the base. In addition, the design provides concrete-arch toe dams, to resist any spreading action of the fill, and an extensive system of downstream drains. At present the diversion system and foundation work have been completed, and about 30 per cent of the 1,700,000 cu.yd. of semi-hydraulic fill has been placed. Fill is being placed at the rate of about 12,000 yd. per day, and the dam is scheduled for completion in October, 1934.

*Water-Supply Situation*—The city of San Diego, located in the extreme southwest corner of the United States, has a population of about 160,000 people. The climate is arid with fairly

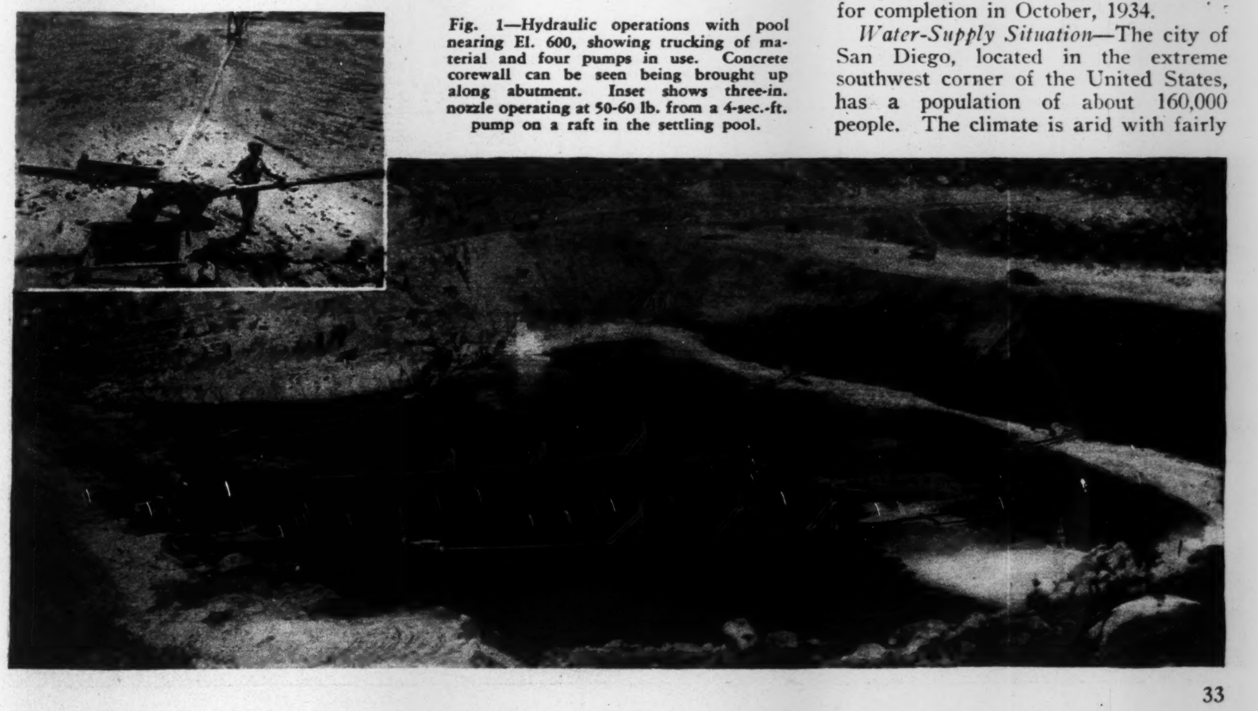


Fig. 1—Hydraulic operations with pool nearing El. 600, showing trucking of material and four pumps in use. Concrete corewall can be seen being brought up along abutment. Inset shows three-in. nozzle operating at 50-60 lb. from a 4-sec.-ft. pump on a raft in the settling pool.

well defined eleven-year intervals between seasons of heavy rainfall and runoff, and this supply has to be stored and held over for the intervening years. The existing reservoirs (Fig. 3), Hodges Morena, Barrett and Otay, furnish the city a net safe duty of 14 m.g.d. Recourse to pumping from underground sources is required each summer and during emergency periods. After protracted litigation over water rights on the San Diego River had been completed and an agreement with the La Mesa, Lemon Grove & Spring Valley Irrigation District was signed, the development of the El Capitan site about 35 miles northeast of the city was possible as an immediate addition to the municipal supply.

For an ultimate supply, the city, in common with other communities in southern California, must look to the Colorado River. In this connection the city has completed negotiations to assure a 100-m.g.d. supply from the Colorado River when required, with an additional agreement to provide for its conveyance through the All-American Canal to a point on the west side of the Imperial Valley from where it could be placed in the San Diego River watershed above El Capitan reservoir by a 1,000-ft. pumping lift and a 28-mile tunnel.

The drainage area above El Capitan site is 178 square miles, and the average annual runoff is 24,600 acre-ft., having an extreme variation ranging from zero for several years to 194,000 acre-ft. in 1916. Reservoir capacity is 118,000 acre-ft., which includes 10,000 acre-ft. of storage allotted to the use of the La Mesa, Lemon Grove & Spring Valley Irrigation District in accordance with the agreement. The storage available for the city when combined with streamflow is estimated to produce a regulated 10-m.g.d. supply, adding 70 per cent to the existing municipal impounding system.

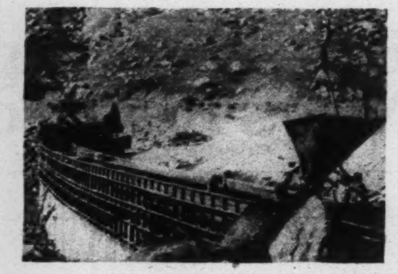


**Fig. 2—Concrete-arch toe dams 50 ft. high provide against any spreading of the fill. Concrete was handled from mixer-body trucks to forms by cranes.**

## Design

El Capitan Dam is designed primarily as a hydraulic-fill structure, with extensive loose rock embankments added on both sides and extending all the way to the crest, and up and downstream concrete-arch toe dams to resist any further possibility of spreading. In other words, regardless of the fact that preliminary tests indicated excellent material for hydraulic-fill operations, the design was prepared to forestall any possibility of the type of difficulty that has always been the problem in the hydraulic-fill type of dam. The proportions and principal dimensions of the structure are shown in Fig. 3. Extensive test borings indicated that any other types of dam was economically impracticable at this location.

The toe dams are concrete arches (Fig. 2) about 50 ft. high and 280 ft. long. They are arched against the fill. Their foundations were sunk about 15 ft. into the firm disintegrated granite below the general streambed excavation. To handle drainage during hydraulicking operations and afterwards, the downstream dam is provided with an extensive system of drains reaching upstream into the rockfill. These drains consist of three 6x7-ft. horeshoe-shaped tunnels at the level of general streambed excavation, extending 150 ft. upstream or about half way to the downstream limit of the hydraulic fill. The upstream ends are closed, but double rows of 6-in. openings were provided along both sides by inserting drain tiles through the concrete wall. The tunnels extend through the concrete toewall, and, to assure continued action of the drains, a concrete shaft extends from each tunnel up the inside face of the toewall to provide access for cleaning. At present the hydraulic-fill operations are not high enough to show drainage.

At the maximum section (Fig. 3) the rock embankments extend about one-half the total base width of the dam and

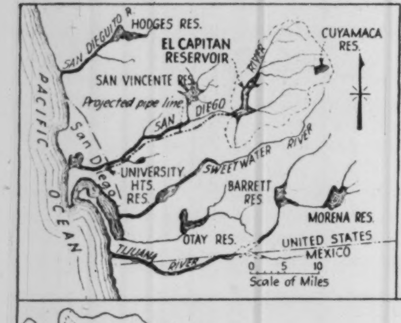
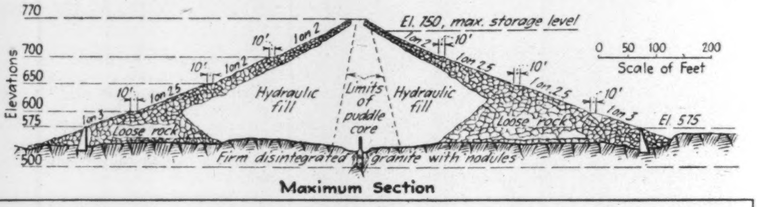
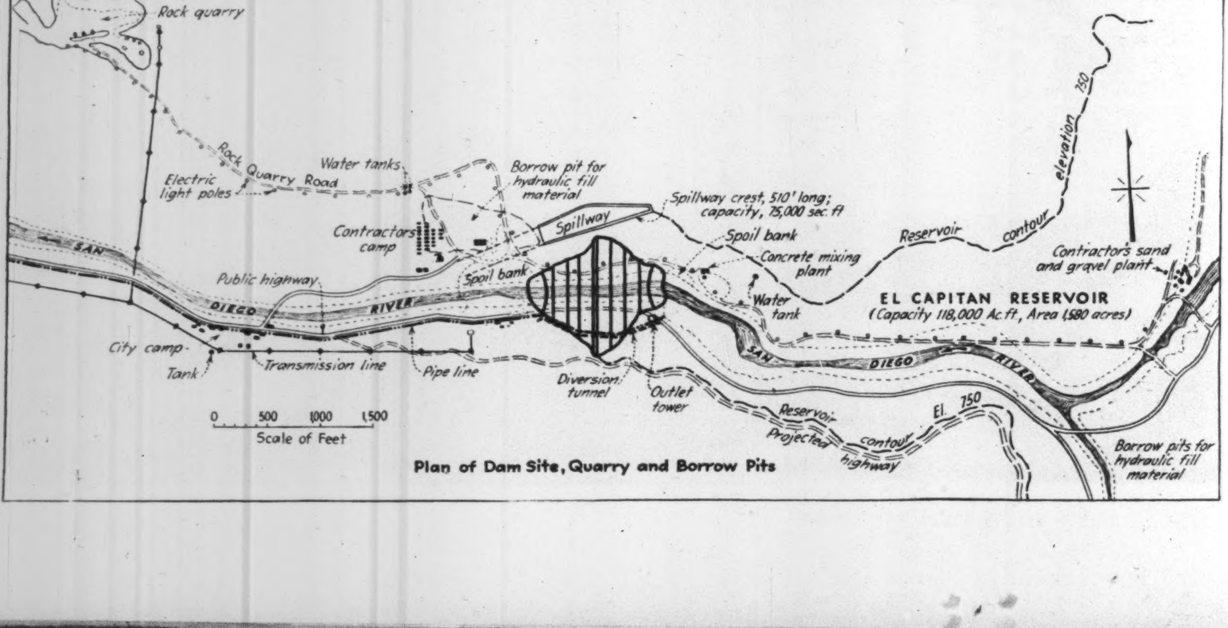

HODGES RES.
SAN DIEGUITO R.
EL CAPITAN RESERVOIR
CUYAMACA RES.
RIVER
SAN VINCENTE RES.
Projected pipe line
SAN DIEGO
PACIFIC OCEAN
San Diego
UNIVERSITY HTS. RES.
SWEETWATER RIVER
BARRETT RES
MORENA RES.
OTAY RES.
UNITED STATES
MEXICO
TIJUANA RIVER
0 5 10
Scale of Miles

**Fig. 3—Relation of San Diego to the local catchment areas and developed storage, with details of the El Capitan site and a maximum section of the dam.**


770
700
650
600
575
500
Elevations
El. 750, max. storage level
10'
1 on 2
1 on 2.5
1 on 3
Hydraulic fill
Limits of puddle core
Loose rock
El. 575
Firm disintegrated granite with nodules
0 50 100 200
Scale of Feet

Maximum Section


Rock quarry
Rock Quarry Road
Electric light poles
Water tanks
Borrow pit for hydraulic fill material
Spillway
Spillway crest, 510' long; capacity, 75,000 sec. ft
Spoil bank
Concrete mixing plant
Contractors camp
Public highway
Water tank
Reservoir contour elevation 750
Contractor's sand and gravel plant
EL CAPITAN RESERVOIR
(Capacity 118,000 Ac.ft., Area 1,580 acres)
SAN DIEGO RIVER
City camp
Tank
Transmission line
Pipe line
Diversion tunnel
Outlet tower
Reservoir contour El. 750
Projected highway
Borrow pits for hydraulic fill material
0 500 1,000 1,500
Scale of Feet

Plan of Dam Site, Quarry and Borrow Pits

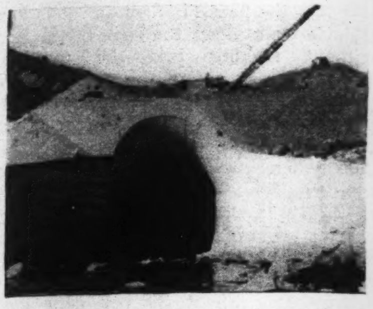


**Fig. 4—Upstream portal of 25-ft. horseshoe-shaped diversion tunnel to be used for two flood seasons and then plugged. The outlet pipe will extend from the tower through the plug to form the start of the 8-mile delivery line.**

completely inclose both toewalls. The outside slopes are faced with a hand-placed layer of rock for appearance on the downstream side and for protection against wave action on the upstream face. Specifications require that the rockfill shall be carried up ahead of the hydraulic fill. There are no special restrictions as to quality or grading except the general approval of the engineer. The inside slope of this loose rock is brought up on a 1:1 slope for about 50 ft. above the dam foundation, and then the fills continue to the crest of the dam in the form of rock blankets gradually decreasing in thickness to a minimum of 2 ft. at the top.

A concrete cutoff wall 6 ft. wide extends along the center line of the dam and was excavated to a maximum depth of about 53 ft. into firm disintegrated granite. This cutoff was backfilled directly against the sides of the trench up to the elevation of the foundation. At this level the concrete wall tapers to a thickness of 18 in., and latticed steel columns (Fig. 5) are provided at 8-ft. intervals. These steel columns act as supports for the system of vertical and horizontal reinforcing bars in the 18-in. thickness of diaphragm that was extended for a height of about 10 ft. into the hydraulic fill. The same type of cutoff trench and wall is being carried up along the abutments. A system of grout holes, 25 ft. deep and 5 ft. apart, was provided at the bottom of the cutoff trench.

The requirements for the hydraulic fill in the central section in general followed the usual specifications for this type of construction, with the control being left in the hands of the engineer. It was required that the bottom of the settling pool be kept level longitudinally, and care was to be exercised in maintaining the elevation of the hydraulic fill on either side of the corewall.

The spillway, located in a saddle immediately to the north, is of side-channel type with a crest length of 510 ft. at an elevation 20 ft. below the crest of the dam. The entire spillway section is lined with concrete and is designed to carry a flood discharge of 70,000 sec.-ft., or about twice the maximum flood of record. Based on the runoff characteristics of the local streams, this spillway capacity, when combined with the ponding effect of the reservoir, will safely take care of a 100,000-sec.-ft. maximum inflow and still leave a freeboard of 8 ft. There are no provisions for spillway gates.

The outlet system is combined with the diversion works in a 25-ft. horseshoe-shaped tunnel 1,200 ft. long under the south abutment of the dam. This tunnel, which is completely lined with concrete, will be used during two flood seasons and subsequently be plugged near the upstream end. Four pipes will be left in the plug connecting with the outlet tower near the upstream portal, and two of them will be extended through the tunnel and constitute the beginning of the 48-in.-diameter supply line.

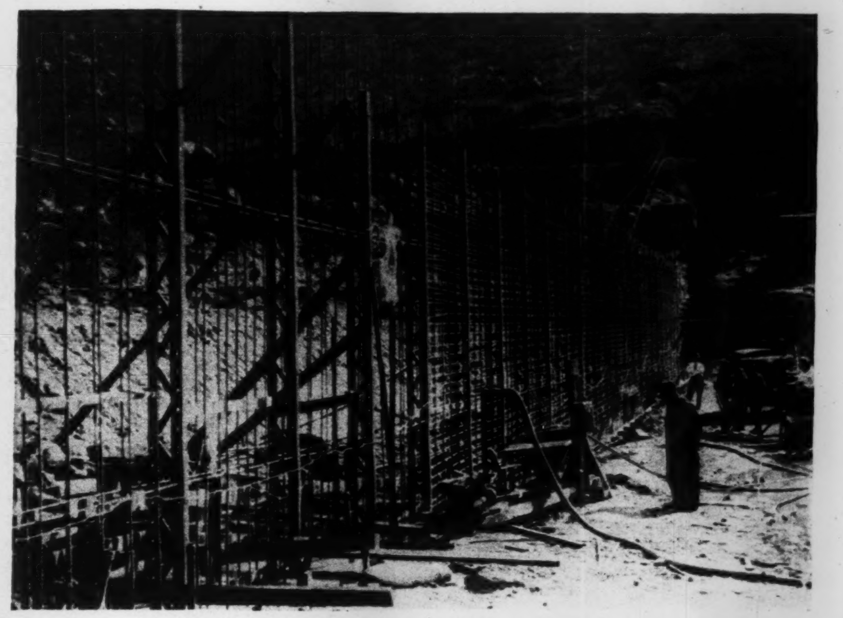


**Fig. 5—Corewall steel consisting of latticed posts 8 ft. c. to c. with ⅞-in. vertical reinforcing at 16-in. spacing on each side and ⅞-in. horizontal reinforcing at 6-in. spacing on each side. This reinforced-concrete wall, 18 in. thick, was carried up 10 ft. into the hydraulic fill.**

## Construction

Following the award of contract in April, 1932, the contractors erected a 250-man camp and shops on a flat area immediately downstream from the dam site. Work was started at once on the excavation of the site, driving of the diversion tunnel and the opening up of the rock quarry.

The dam site was stripped of 300,000 cu.yd. of overburden to a depth of about 25 ft. in streambed, decreasing to a minimum of about 5 ft. on the side hills. This material was removed by power equipment and trucks. From this foundation level on satisfactory material the cutoff trench was excavated an additional 53 ft. to a denser material of the same general character, and grout holes 5 ft. on center were then sunk along the bottom of this trench to an additional depth of about 20 ft.

In the meantime the diversion tunnel was being driven, using a 12x14-ft. pioneer bore followed by bench excavation and completed with the removal of the invert. The pioneer tunnel was excavated with mucking machines and cars on track, while bench excavation was handled by power shovel and trucks. This work was completed in time to handle the winter runoff. So far water problems have not affected construction operations.

The foundations for the two toe dams were excavated 15 ft. below the general foundation level, and concrete was deposited in 5-ft. lifts by cranes from mixer-body trucks. These structures were completed within five months. Concrete for the 65,000 cu.yd. required on the project is produced in a plant containing two 1-cu.yd. mixers, using aggregate screened at the site.

A suitable quarry was opened up about 1½ miles below the dam site. After preliminary operations, using 30-ft. lifter holes spaced at 12-ft. intervals, well-drilling equipment was used to develop a quarry face almost 2,000 ft. long. Rock is loaded by electric and gasoline power shovels and trucked to the site. During the early stages of the quarry operations about 5,000 cu.yd. was moved in two shifts per day, but recently this output has been reduced to 60,000 cu.yd. per month to maintain the rockfill at the proper level with respect to hydraulicking operations.

Because of the type of dam the restrictions as to size and character of rock are not severe, and practically all

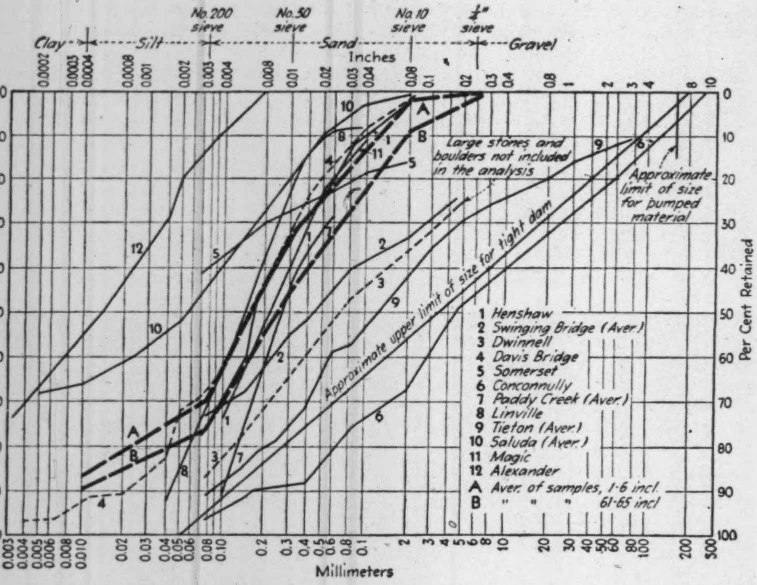


Fig. 6—Relation of El Capitan Dam borrowpit grading curve to those of other well-known hydraulic-fill dams.

hard rock from the quarry output is used. The principal purpose of the rock embankments is to provide weight and drainage, and the rock-to-rock contact required in a strictly rockfill structure is not so important.

*Hydraulic Fill*—A large deposit of graded clayey material originating from granite about 1½ miles upstream from the dam site provides the main clay and fines for the fill material. No stripping is required, and the material is excavated without difficulty by power shovels and loaded into trucks. The pit was extensively tested and was found to grade well within the limits established by other dams of this type. The accompanying chart indicates the grading of the material compared with that in other dams (Fig. 6).

To provide a more porous fill on the outer edges near the rock embankments, decomposed granite taken from the excavation is being added. This coarser material permits a more uniform grading from the puddle core to the rockfill and improves drainage. Also, it may allow the use of as much as 500,000 cu.yd. (66 per cent) of the spillway excavation that would otherwise have to be wasted. Tests indicate that when washed this material provides some fines that improve the grading curve of the core.

Arriving at the dam, the trucks from the borrowpit or spillway operate on the rock embankments and end-dump into the hydraulic-fill section (Fig. 6). Bulldozers are used to spread and move this fill to the streams from the giants. Hydraulic-pumping equipment is raft-mounted in the pool and consists of two 3-sec.-ft. pumps, using 2-in. nozzles, and three 4-sec.-ft. pumps, using 3 in. nozzles (Fig. 1), all electrically operated. The pressure used is between 50 and 60 lb., and the maximum length of 8-in. steel pipe line to the nozzles is about 200 ft.

Close control is maintained over the position of the pool and various features of the hydraulic operation. The edges of the pool are held as close as possible to a distance of 15 ft. outside the theoretical limit of the desired puddle core. This distance was determined from tests indicating that the puddle material deposits on about a 45-deg. angle, and a 6-lb. weight shows that the depth of pool varies from 8 to 12 ft.

The excellence of the material for this type of operation is indicated by the fact that the beach is firm and it is possible to walk along the edge of the pool without sinking into the material. About 70 per cent of the core material passes the 100-mesh sieve, and about 15 per cent can be classed as clay. The specific gravity of the core is about 2.06 when retaining 38 per cent of moisture, while that of the quarry rock is 2.74. Hydraulic-fill operations are carried on two shifts per day, and from 8,000 to 12,000 cu.yd. is placed. The pool has reached an elevation of 600 ft., representing about 30 per cent completion of the 1,700,000 cu.yd. to be placed by this method.

Samples of the core are taken every ten days along the edge of the pool and along the center line and indicate that the grading determined by tests on the borrowpit is being obtained in the core. The type of material, its weight and general characteristics indicate that there are no particular problems involved in its use, and the tests or studies do not differ from usual procedure.

The make-up water required for pool operations at the present time it about 150 gal. per cu.yd. of placed material, which represents approximately the amount of water required to fill the voids.

*Organization*—The El Capitan Dam project is being carried forward under the direction of the author. Fred D. Pyle is principal assistant and Harold I. Wood is resident engineer. D. W. Albert is in direct charge of the hydraulic operations.

The $2,332,000 contract for the dam and accessories is held by H. W. Rohl and T. E. Connolly, as joint contractors. O. C. Steves is superintendent.

# Vermont-New Hampshire Boundary Fixed by U. S. Supreme Court

ENDING a dispute begun in 1915, the United States Supreme Court, on May 29, fixed the boundary line between the states of Vermont and New Hampshire at the low water mark on the western side of the Connecticut River. The state of New Hampshire claimed the boundary line to be the top or westerly margin of the westerly bank of the Connecticut River and of the branch thereof, and Vermont claimed the boundary to be the thread of the channel of the Connecticut River for its entire course except for that part of the northerly limits of the town of Vernon, Vt., south to the Massachusetts line, where it was claimed to be the west bank of the river at low water mark.

In fixing upon the boundary line the Supreme Court went back to an order of the King-in-Council of July 20, 1764, fixing the boundary between the provinces of New York and New Hampshire as the "western banks of the River Connecticut." The court further noted that Vermont had by resolution of her legislature of February 22, 1782, relinquished any claim to jurisdiction east of the west side of the river at low water mark, in conformity to a Congressional resolution prescribing the terms upon which Congress would consider the admission of Vermont to the Union. The line thus specified was defined as "the point to which the river reaches at its lowest stage without reference to extreme drought."

As to whether the western bank is the low water mark or the top of the bank, voluminous testimony was introduced by New Hampshire to establish it as the top of the bank, but in the light of many historical references to the boundary and the fact that the marker established by joint action of the two states in 1894 to mark the southeast corner of Vermont and the southwest corner of New Hampshire was set at low water led the court to conclude that the line should be at low water.

# How the Highway Pays—III

## *Analysis of Earnings*

### Cost of highways balanced against vehicle taxes, savings in operation and intangible benefits

**By R. W. Crum**

*Director, Highway Research Board, National Research Council, Washington, D. C.*

In Two preceding articles the liquidation of highway improvements by motor-vehicle tax returns and the vehicle-operating economies due to better travel surfaces have been appraised. How relative transportation costs broken down to basic units can be used in judging the soundness of proposed improvements are discussed in this third and concluding article. EDITOR.

GENERAL-USE HIGHWAYS should be so constructed that transportation will be furnished at the lowest cost for road service and vehicle operation consistent with adequate provision for the traffic. The revenues derived from the use of the roads through license fees and taxes upon gasoline should in general be made large enough to defray the annual highway cost.

The application of these principles to the study of individual improvement projects involves determination of the probable annual cost, the amount of traffic, the vehicle-operating costs and the tax revenues. The effect of the improvement upon transportation cost is the most significant factor. Vehicle-operating cost depends principally upon the type of road surface, although the elements of distance, time saving and grade reduction are important. Since the object of this article is to illustrate the basic principles, it will be confined to discussion of a case involving only change of surface type. Detailed discussions of the economic significance of other factors have been presented by Lavis[1], Johannesson[2], and Agg[3].

In the 1930 report of the committee on highway transportation economics of the Highway Research Board the cost of transportation was computed over 26.3 miles of paved road between Ames and Des Moines, Iowa. In a paper presented before the highway division of the American Society of Civil Engineers on Oct. 7, 1932, Dean Agg compared these costs with those prevailing before the road was changed from plain gravel to concrete. With his permission his basic figures are here used to illustrate the economic result of providing a busy road with a first-class modern pavement in replacement of a traffic-bound untreated gravel road. The treatment, however, varies somewhat both from that of Dean Agg and that of the transportation committee.

Table I gives the basic cost data for the road before and after improvement. The average annual costs may be computed on a theoretical basis, in which case it is assumed that the investment is maintained intact for an indefinite period of time by keeping the surface in standard serviceable condition; or the costs may be compared for certain finite periods of time during which all or part of the investment cost is liquidated.

In order to illustrate the principles involved, the computations will be made in both ways.

### Theoretical basis

*Gravel Surface*—The annual cost for an indefinite period would consist of the interest on the investment plus maintenance and administration costs plus the annual deposit necessary at compound interest to produce $34,300 every three years for pericdic maintenance.

| | |
|---|---|
| Interest on $482,425 @ .045 | $21,709 |
| Maintenance and administration | 21,500 |
| Deposit for periodic maintenance @ .0425. | 10,960 |
| Total average annual cost | $54,169 |
| Average per mile | $2,060 |

*Paved Surface*—Since theoretically the invested value is assumed to continue in existence indefinitely, the investment upon which interest must be charged will have to include the investment in the old gravel road plus the additional cost of converting it to a paved surface. The amount is $1,328,125. It is estimated that at 25-year intervals $308,500 will have to be expended to restore it to the equivalent of its original condition.

| | |
|---|---|
| Interest on $1,328,125 @ .045 | $59,765 |
| Maintenance and administration | 9,893 |
| Deposit for periodic maintenance @ .0425. | 7,160 |
| Total average annual cost | $76,818 |
| Average per mile | $2,920 |

### Costs based on liquidation of investment

*Gravel Surface*—This road was maintained with an untreated traffic-bound gravel surface for eight years. Since there was no salvage value in the surface, the annual cost for the eight-year period must include an item for the liquidation of its cost in that time and also for that part of the original investment spent for engineering and administration. The investment in right-of-way, drainage structures, earthwork, signs and appurtenances need not be liquidated.

| | |
|---|---|
| Interest on investment in permanent items—$376,950 @ .045 | $16,963 |
| Annual payment of principal and interest to liquidate $105,475 in 8 years @ .045 | 15,999 |
| Maintenance | 21,500 |
| Average annual cost of periodic maintenance ⅛ of $68,600 | 8,575 |
| Total average annual cost | $63,028 |
| Average per mile | $2,396 |

*Paved Surface*—It is estimated that the paved surface can be kept in standard serviceable condition with only ordinary maintenance for 25 years, at which time extensive rebuilding, estimated at $308,500, will probably be necessary. This amount, which is estimated depreciation together with the $70,500 expended for engineering and administration, should be liquidated in the 25 years. The investment in right-of-way, drainage structures, earthwork, signs and appurtenances ($381,150) and the salvage value of the pavement ($462,500), totaling $843,650, are permanent enough to be continued. No periodic maintenance is expected during the 25 years, so nothing is included for that purpose.

TABLE I—COST DATA, U. S. HIGHWAY 65, BETWEEN AMES AND DES MOINES, IOWA

| Item | As a Gravel Surface | Additional for Payment |
|---|---|---|
| Right-of-way | $38,000 | ........ |
| Drainage structures | 132,950 | ........ |
| Earthwork | 204,000 | ........ |
| Signs and appurtenances | 2,000 | $4,200 |
| Gravel surface | 84,700 | ........ |
| Pavement and incidental costs | ........ | 771,000 |
| Engineering and administration | 20,775 | 70,500 |
| Sum of investment items | $482,425 | $845,700 |
| Maintenance and administration Average per year | $21,500 | $9,893 |

| | |
|---|---|
| Interest on $843,650 @ .045 | $37,964 |
| Annual payment of principal and interest to liquidate $379,000 in 25 years @ .045 | 25,545 |
| Maintenance and administration | 9,863 |
| Total average annual cost | $73,372 |
| Average per mile | $2,790 |

It seems reasonable not to try to look into the future for more than 25 years, so as a practical matter the comparison covering definite periods of time is probably preferable. The figures on this basis will therefore be used in the rest of the discussion.

### Roadway cost per vehicle mile

In order to combine the roadway cost with vehicle-operating cost to show that of highway transportation, it is necessary to reduce them both to costs per vehicle-mile or per ton-mile. The ton-mile would no doubt provide the best basis; but since traffic surveys are not often made in such a way that ton-miles can be measured, the vehicle-mile is quite generally used as the traffic unit, especially in cases where the percentage of heavy commercial vehicles is slight. On heavy traffic roads carrying a large percentage of commercial cars, traffic surveys preliminary to consideration of improvement projects should at least divide the traffic by weight classification. A difficulty in the use of the ton-mile as a traffic unit at this time is the lack of information on the ton-mile cost of vehicle operation.

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[1] "Highways as Elements of Transportation," Fred Lavis, *Transactions*, Am. Soc. C.E., Vol. 95.

[2] "Cost of Traffic Delays," S. Johannesson, *Civil Engineering*, March, 1933.

[3] "Economics of Proposed Highway Expenditures." T. R. Agg, *Civil Engineering*, December, 1932.

The average traffic on the gravel-surfaced road during the eight-year period was about 700,000 vehicles per year. If the improvement is found to be advantageous to these vehicle-users, there can be no question of the economic soundness of the project. It will be based upon known and not upon estimated future traffic.

The roadway cost per car-mile is equal to the annual road cost per mile divided by the number of cars passing over a mile annually.

The roadway costs are therefore:

$$\text{Gravel road} = \frac{\$2,396}{700,000} = \$.0034$$

= 0.34c. per car-mile.

$$\text{Pavement} = \frac{\$2,790}{700,000} = \$.0042$$

= 0.42c. per car-mile.

*Vehicle - Operating Costs* — There were comparatively few trucks and buses operating over this road, so the operating costs for the imaginary average automobile reported by Dean Agg will be used.

The average automobile-operating costs less contributions to road funds are estimated to be:

| | Cents Per Mile |
|---|---|
| On gravel surfaces | 6.09 |
| On pavements | 5.14 |

**Transportation Costs**

| | | Cents Per Car-Mile |
|---|---|---|
| On gravel surfaces | 0.34+6.09= | 6.43 |
| On pavements | 0.40+5.14= | 5.54 |
| Net saving | = | 0.89 |

*Savings*—We have now arrived at the significant result of the computations. The net saving to each of the cars habitually using this road by reason of the pavement construction will be 0.89c. for each mile traveled. For the 26.3 miles and 700,000 vehicles per year the total annual savings will be $164,000. Compare this with the estimated annual road cost of $73,372, and it is obvious that the project is economically sound and in the public interest.

*Earnings*—To pay the cost of the road service, the state collects the money from the road users by means of license fees and taxes on gasoline. The rates are fixed by statute and do not bear any particular relation to the costs of an individual road section. However, from the known traffic and tax rates the revenue derived directly from this road can be estimated.

For this purpose it is assumed that the license fee is a charge for state road service, that the entire proceeds should go to the state system, and that the gasoline tax should be distributed on the basis of proportionate road use.

*License Fee* — During the period 1925-'31 in Iowa this source yielded $11,000,000 per year for 7,789 miles of state roads, or $1,400 per mile.

*Gasoline Tax*—As previously shown, 1.09c. of the total operating cost of the average automobile per mile is attributed to the cost of gasoline. Assuming the price of gasoline at 20c. per gallon, the amount of tax paid by each vehicle at 3c. per gallon will be

$$\frac{1.09 \times 3}{20} = 0.16\text{c. per car-mile.}$$

The gas-tax revenue per mile on this road is therefore 700,000×$.0016 = $1,120.

The total revenue earned by the road at existing tax rates when completed was $1,400 + $1,120 = $2,520 per mile, which is slightly less than the estimated annual cost for the next 25 years. However, the improvement was jusified by the prospective economy. Since the traffic had been steadily increasing on this road for some time and since a pavement would be bound to attract traffic from neighboring unimproved roads, it was furthermore reasonable to expect a considerable increase in a comparatively short time. This expectation turned out to be justified, as by the summer of 1930 the traffic had grown to about 1,000,000 vehicles annually, which increased the gas-tax revenue generated by this road to $1,600, making the total revenue $3,000. By this improvement, without increase in tax rates, the original traffic of 700,000 vehicles per year was enabled to save $164,000 annually, and the 300,000 cars per year of new traffic were provided with a wanted service at minimum vehicle-operating cost.

## Résumé of economies

Those rural roads whose principal function is to serve traffic, in contradistinction to those whose purpose is to give access to the land, constitute in effect a public utility, and they can most easily be evaluated from that standpoint. The operating unit is the state highway system, and the best conception of highway finances can be had by the analysis of such a system.

## Annual costs

The annual cost of a highway system comprises four items: administration, maintenance, depreciation and investment service. Under an ideal arrangement a sum of money would be set aside each year at compound interest to provide funds at stated intervals for restoration, thus maintaining the investment intact; in which case the only investment service would be the interest. Over a long period the true average annual cost can be determined in this way.

In practice, however, it is more usual to think of annual costs as consisting of administration, maintenance, depreciation, interest and payments for liquidation of the investment. Occasionally sinking funds are set up to provide money in the future for extensions, betterments and renewals.

In estimating probable future annual costs, I believe the most practical method is to include the following items:

1. Amortization of the probable depreciation from the present value in from 20 to 30 years. All borrowed money, even in excess of depreciation, should be liquidated in this time.
2. Administration.
3. Maintenance.
4. A sum to be set aside each year to provide funds for extensions, betterments and renewals.

Determination of present value is complicated and difficult, for the state highway systems have been developed piecemeal over a considerable period of time. The best method, although tedious and costly, would be to sum up the values determined for individual road sections as described by the transportation economics committee of the Highway Research Board.

Perhaps for general study, estimates arrived at more simply may suffice. For instance, the cost of building the system at present prices could be estimated, or the total amounts spent for construction on the system to date, less an allowance for depreciation, could be used.

## Earnings

The state highway systems receive incomes from license fees upon motor vehicles and from taxes upon fuel. These receipts are fixed arbitrarily by statute and bear no definite relation to the revenue earned by the system. The earned revenue consists in all or part of the license fees and that part of the total gasoline tax derived from travel upon the state system.

The state is certainly justified in charging every motor vehicle a "readiness to serve" charge for providing the state road system. In a given state this might be any part or all of the license fees depending upon local conditions. It should probably bear some definite relation to the highway investment and the number of cars licensed.

The amount of the gasoline tax attributable to travel on the state highway system is definite and merely requires a knowledge of the amount of traffic on the system for its determination.

An adequate traffic survey is essential. No public utility can be analyzed without knowledge of the extent of its use.

The logical basis for the division of the returns from gasoline taxes among the general-use highways, the land service roads and municipal streets is that of the proportionate amount of traffic carried by each.

If the earnings of the highways are equal to or exceed the annual cost of providing the roads, then the system is in a sound position financially and, if the tax rates are fair and reasonable, cannot be considered to be a burden upon the taxpaying public. But another factor of major importance in the justification of road improvements is that highway transportation, including both road and vehicle costs, should be furnished as economically as possible. In order to arrive at the significant figure of cost per car-mile or per ton-mile, knowledge of highway costs, vehicle-operating costs and amount of traffic is necessary. The costs of operating vehicles over different kinds of road surfaces vary considerably; hence the need for studying transportation cost in working for economy.

On lightly traveled roads the highway cost will predominate, and on heavily traveled roads the vehicle-operating cost will be the deciding factor.

The most important criteria that a contemplated general-use road-improvement program should meet are: Will it be self-supporting? Will it lessen the cost of highway transportation? Will it reduce accident hazards?

In this discussion only three features of road improvements that can most readily be evaluated in money have been considered. There are, of course, certain other more or less intangible benefits accruing from highway improvements that should be taken into account before the final estimate of value is made. Among them are: saving in distance, saving in time, elimination of congestion, grade reduction, beneficial effects upon public health, educational progress, recreational facilities, etc. The very important social benefit resulting from reduction of accident hazards can be only partly evaluated.

# Bell Splice Composite Pile Developed in Texas

**Long concrete approaches to Neuces River crossing near Corpus Christi are carried on square precast concrete piles having a bell-shaped bottom that fits over a timber pile driven to bearing on stiff clay**

By G. G. Wickline
*Bridge Engineer, Texas Highway Department, Austin, Texas*

IN THE construction of the new bridge carrying state highways Nos. 9 and 128 over the Neuces River Valley at a point about 10 miles upstream from Corpus Christi Bay the use of a special composite pile is notable. The lower portion of these composite piles is of timber. On top of this is set a precast concrete pile 16 in. sq. and 17 ft. long, of which the bottom 3 ft. is cast in the form of a hollow cylinder or bell that fits over the timber pile, forming an effective joint or splice. More than 400 of these composite piles were successfully used. The bid price for the 16-in. square precast piles was $1.94 per linear foot, while the precast concrete splice bells were bid at $12.80 each.

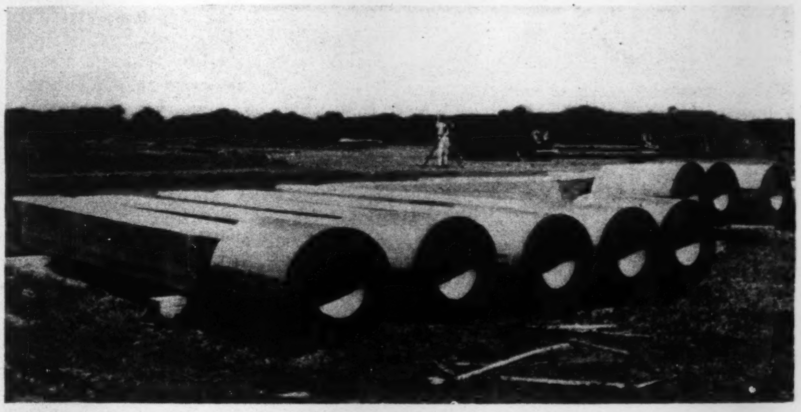
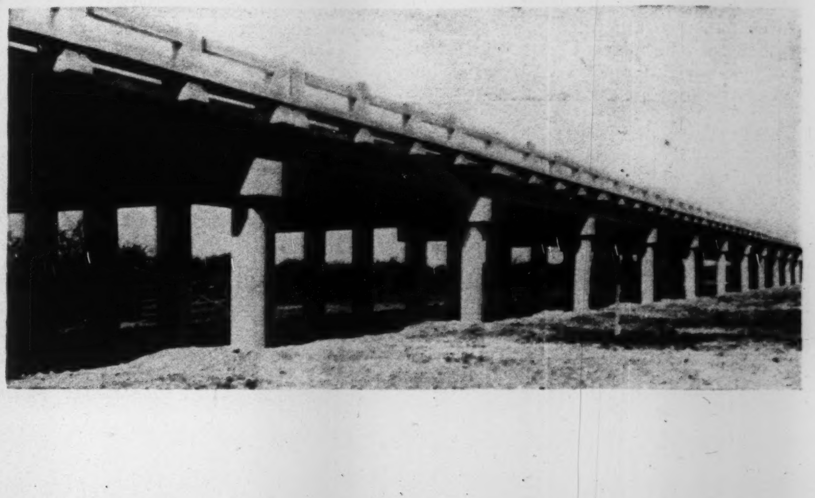


**Fig. 1—Bell-bottom precast concrete piles that comprise the top half of the composite piles used on the approaches to the Neuces River bridge in Texas. The bell fits over the timber bottom section, forming an effective splice.**

The Neuces River Valley is wide and flat. Since the main channel is rather small, floodwaters cover the valley for a depth of 8 to 10 ft. for a width of about one-half mile. The average ground level is about 8 ft., above low-water level in the Gulf of Mexico, of which Corpus Christi Bay is an arm. Borings disclosed an 8-ft. layer composed of clay, sand and top soil, under which was a stratum of water-bearing sand varying in depth from 10 to 15 ft. Below the water-bearing sand was a 50-ft. layer of stiff yellow clay. The plans for a bridge over this valley were prepared on the basis of a total length of bridge of 2,785 ft., made up of one 130-ft. steel-truss span for the main channel and a series of 30½-ft. concrete-girder approach spans set on five-pile bents. On the north end 50 spans were used, and on the south end there were 37. The roadway of the structure, which is of deck type, is 22 ft. between curbs, and the design was prepared so that the floor slab might be finished for the full width and the concrete curb and railing constructed at a later date, attached to the floor by means of dowels. Details of the deck are shown in Fig. 3.

## Approach bents

The bents of the approach spans consist of five composite piles, topped with a 24x30-in. concrete beam. The upper portion of the pile is of precast concrete 16 in. square, with an average length of 17 ft. On the bottom of this concrete pile is a reinforced-concrete bell-shaped projection 3 ft. long and 2 ft. in diam-

**Fig. 2—Approaches to Neuces River bridge consist of eighty-seven 30½-ft. concrete girder spans set on five-pile bents.**


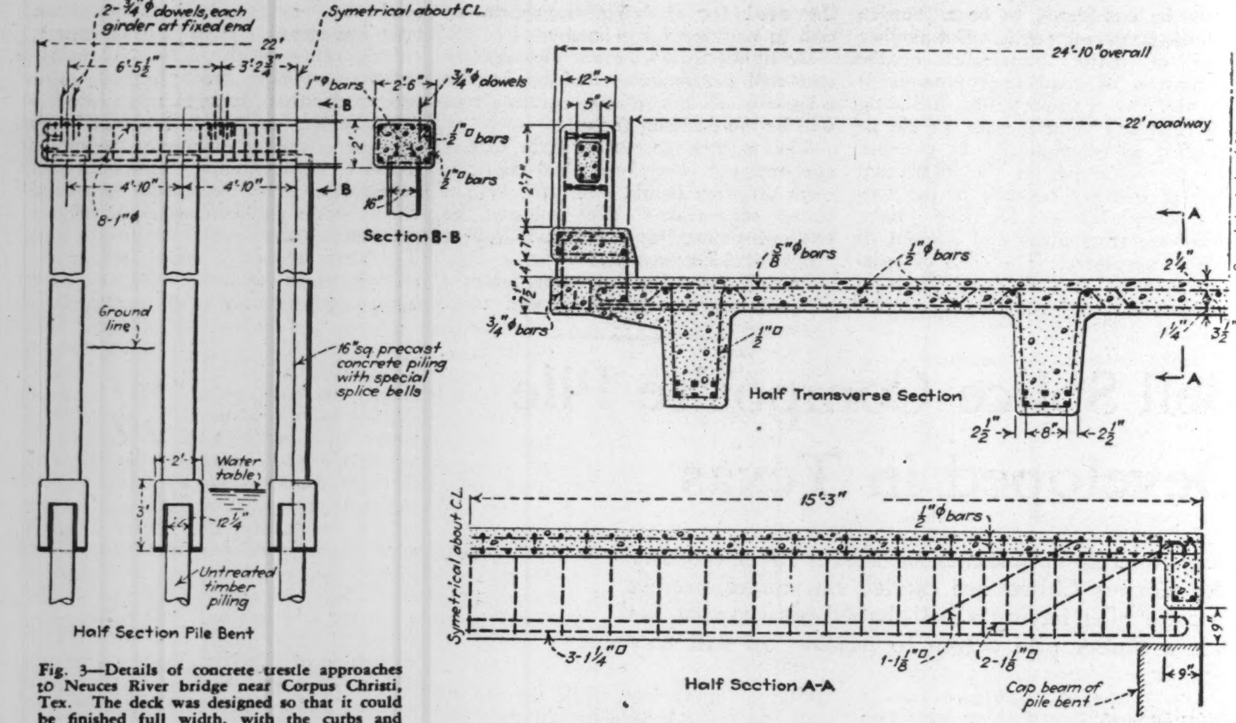

2-3/4"ϕ dowels, each girder at fixed end
Symetrical about CL.
22'
6'-5½"
3'-2¾"
1"ϕ bars
2'-6"
3/4"ϕ dowels
B
2'
½"□ bars
½"□ bars
4'-10"
4'-10"
8-1"ϕ
16"
Section B-B
Ground line
16"sq. precast concrete piling with special splice bells
2'
Water table
3'
12¼"
Untreated timber piling
Half Section Pile Bent
24'-10" overall
12"
5"
22' roadway
2'-7"
A
5/8"ϕ bars
½"ϕ bars
2¼"
3/4"ϕ bars
½"□
1¼"
3½"
Half Transverse Section
2½"
8"
2½"
15'-3"
½"ϕ bars
Symetrical about CL.
9"
3-1¼"□
1-1⅛"□
2-1⅛"□
9"
Half Section A-A
Cap beam of pile bent

**Fig. 3—Details of concrete trestle approaches to Neuces River bridge near Corpus Christi, Tex. The deck was designed so that it could be finished full width, with the curbs and railings installed later.**

eter, with a cavity 2 ft. deep and 12¼ in. in diameter, designed to fit over the top of an untreated timber pile (average length about 35 ft.), which forms the bottom portion of the composite pile. On the average, about 8 ft. of the concrete pile extends into the ground. Details of these piles, including the reinforcing required, are shown in Fig. 4.

On the bottom of the splice bell a ½-in.-thick metal washer is attached by four ⅝-in. machine bolts 6 in. long. This washer served as a cutting device over the top of the timber piling and also prevented splitting of the concrete splice bell during driving. The section of the timber pile entering into the splice bell was formed with a templet to the exact diameter, material being slightly seasoned southern pine specially selected for straightness. Previous to driving, the top of the timber pile was covered with burlap saturated with water in order to cause the full swelling of the timber to take place before the splice bell was driven on. This assured the necessary snug fit at the splice.

The concrete piles were made with a 1:2:3½ mix, cured by a cover of moist earth sprinkled with water four times per day. This permitted the piles to be driven at the end of 28 days, at which time test cylinders indicated a minimum strength of 4,000 lb. per sq.in.

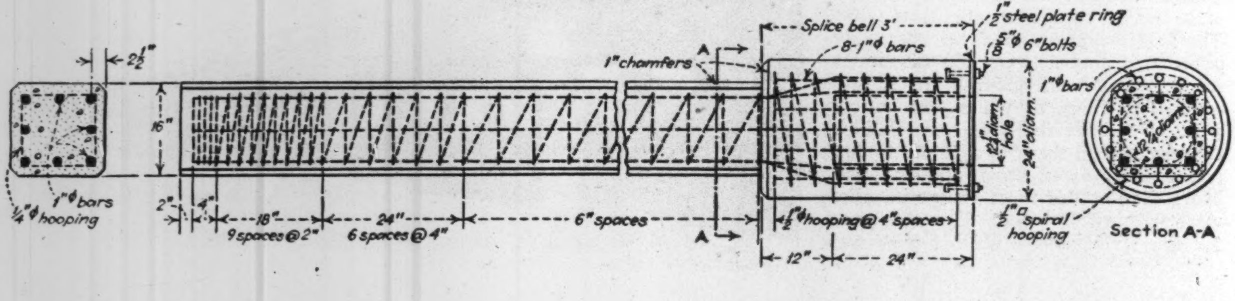
## Piledriving procedure

The specifications provided that the timber portion of the piling should be driven to within about 1 ft. of the ground surface, after which the concrete portion of the pile was set in place and the driving continued to the required resistance and penetration. In general, very good resistance was obtained for all of the bents. In a few cases it was necessary to drive the piling below cutoff grade and make a splice build-up for the concrete portion of the pile. An average resistance of 60 tons per pile, as computed by the *Engineering News* formula, was obtained. All piles were driven to an elevation so that the top of the timber portion of the pile was 1 ft. below low gulf level to insure its being below the permanent water line.

After the piles were driven in place and properly lined up by clamping heavy timbers on each side, a reinforced-concerte cap was cast in place. After this had cured for a period of two weeks, backfill was placed around the concrete piling on top of the splice bell and thoroughly tamped.

The design for the structure was prepared in the bridge design division of the state highway department. The engineering supervision of the work was under general direction of E. F. Maddox, and under direct supervision of R. W. Stiles, of San Antonio, who acted as resident engineer throughout the work. The H. K. McCollum Co., of Fort Worth, as general contractor, precast all the concrete piles and drove part of them. The remainder of the work was performed by R. W. Briggs & Company, Pharr, Tex. The contract price was $95,851. The cost of the concrete-girder approach, including 10 per cent added for engineering and contingencies, was $38.42 per linear foot.

**Fig. 4—Reinforcing details of precast concrete section of composite pile, showing bell splice that fits over timber bottom section.**


2½"
16"
1"ϕ bars
¼"ϕ hooping
2"
4"
18"
9 spaces @ 2"
24"
6 spaces @ 4"
6" spaces
1" chamfers
A
Splice bell 3'
8-1"ϕ bars
½" steel plate ring
⅝"ϕ 6" bolts
12¼" diam. hole
24" diam.
¼"ϕ hooping @ 4" spaces
12"
24"
1"ϕ bars
½"□ spiral hooping
Section A-A

# NEW PLANS FOR THE MISSISSIPPI

## General Hydraulic Phenomena Studied With Models

*Fourth of a Series of Eight Articles*

**Notable experimental work performed on bed-load movement, sediment discharge, erodibility of bed soils, sand transportation, hydraulic effects of cutoffs and life of dredged channels at bars**

INVESTIGATIONS at the U. S. Waterways Experiment Station at Vicksburg, Miss., have been directed, as stated in the previous article, toward the determination of general hydraulic phenomena as well as to the study of specific improvement problems. Commonly both objectives have been parts of the same investigation. In this article experiments have been selected that have developed general hydraulic phenomena. In respect to some of these, confirmatory evidence appears in the results of other tests, but in the present summary only the main studies directed specifically to the determination of a particular phenomenon are considered. Also various tests for calibrating models, for developing model materials and for verifying instruments and appurtenances and processes used in testing are not discussed.

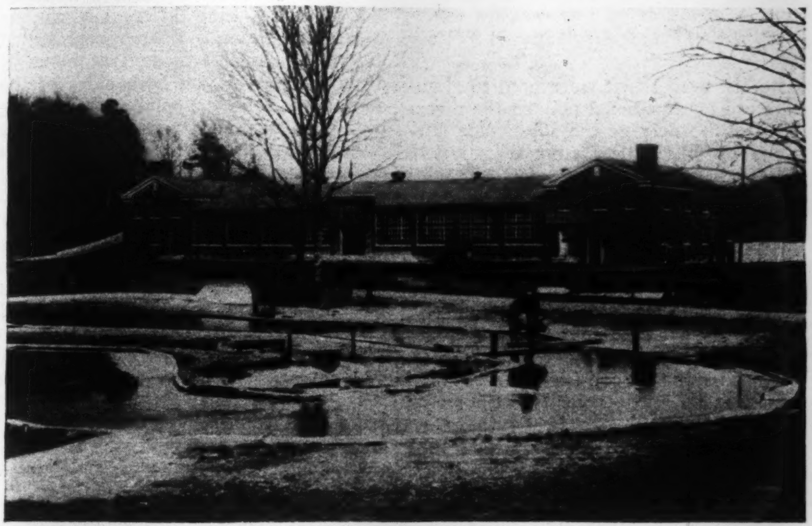


**Fig. 1—Model for investigating current travel, bed-load movement and deposition at river bends.**

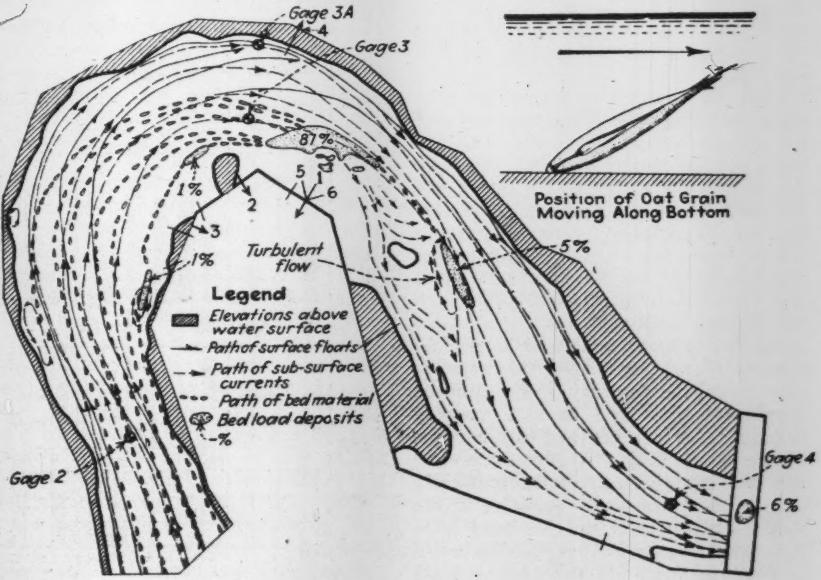
The phenomena of general interest given special laboratory and model study include bed-load movement, effect of dredging bars, hydraulic effects of cutoffs, sediment saturation and discharge determinations, erodibility of soils in channels and erosion and transportation velocities for sand movement. Both the number of these experiments and the volume of the recorded data permit only summaries of the findings and conclusions.

### Bed-load movement at bends

Bed-load movement, or material movement along a riverbed, presents the most critical problem to river engineers at bends in the river. At bends the action of the water is to scour the concave bank, and deposit material on the concave bank and form a point bar. The prevailing theory of this action comes up for consideration in a succeeding paragraph. A model experiment was undertaken to determine by test the physics of the transportation of bed-load material around bends, the manner and place of its deposition and the practicability of removing some of the material from the bed of the main stream by diversion channels.

The section of river selected for modeling was that from mile 51 to mile 67 in which, between mile 59 and mile 63, Slough Bend shifts the direction of flow 180 deg., as indicated by Figs. 1 and 2. The model was an extension of the model selected for illustrating model design in the preceding article. This extension, which included the bend, conformed in all scales to the portion added to, except that it had a fixed bed to insure unchanging cross-section necessary for current and bed-load movement observations through several cycles.

**Fig. 2—Chart of current and bed-load movement as determined by model shown in Fig. 1. Run was made at high-water stage of 40 ft.**



Eleven test runs were made to determine: (1) current travel and velocity, (2) bed-load travel and deposition, and (3) the effect of diversion channels in removing bed load from the main stream. Floats and dyes (potassium permanganate) were used for tracing surface and subsurface currents. For tracing bed-load movement, oat grains were found by experiment to be excellent indices. Their light specific gravity made them easily moved by low-velocity currents, and their streamline form made them point the direction of the currents moving them. The position of the oat grain in traveling on the bed is shown by Fig. 2, which also shows current travel and deposition at high stages. Lower stages and the introduction of diversion channels changed the main current threads slightly, but materially altered the points of bed-load deposition. A summary of the results is as follows:

In the first phase of the experiment, which investigated the movement of water as it flows downstream around bends, several significant facts were adduced. Hitherto the generally accepted conception of the directions of the currents as they pass around a bend has been very similar to that first advanced by Prof. James Thompson in 1876. This conception, from which the theory of helicoidal flow of water around bends was derived, is as follows:

As the stream passes into the bend the surface currents, due to centrifugal force, pass across to the concave bank, are deflected downward by this bank and then pass the bottom of the stream to the opposite shore at the same time that they are being translated downstream. In this manner the general direction of the motion of flow resembles to some extent the shape of a helix. According to this theory, the currents striking the concave bank generate a scouring action, and the material displaced by this action is transported by the currents across the bottom of the stream to be deposited on the opposite, or convex, shore.

Observations that in nature the concave banks of stream are scoured and the shore lines on the convex side are built out by material placed there by the stream has served to lend substance to this theory. Observations made during this experiment of the manner in which water flows around bends tended to refute it. *In the many test runs there was found no single instance in which the surface currents passed downward along the concave bank and across the bottom of the stream to the opposite shore.* On the contrary, the subsurface currents were found to flow roughly parallel to each other and to the shape of the shore lines. At the same time the bed material introduced uniformly across the transverse section of the model at the head of the bend soon passed across the bed of the channel to a point of focus on the convex bank.

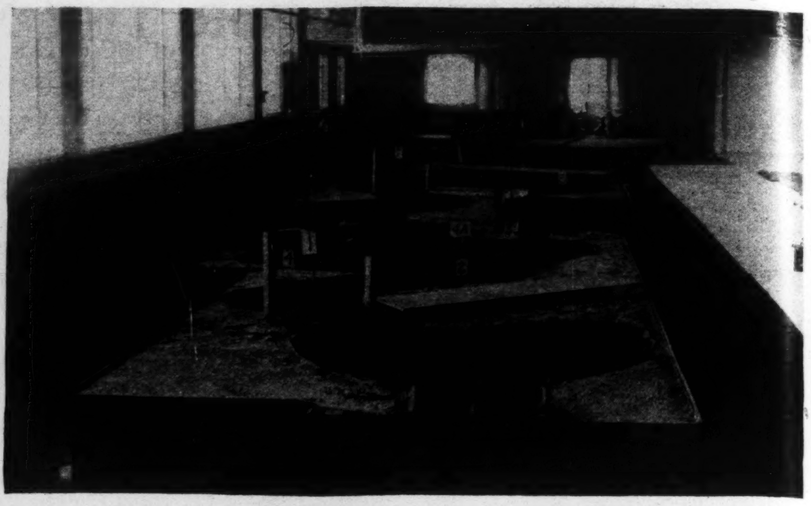


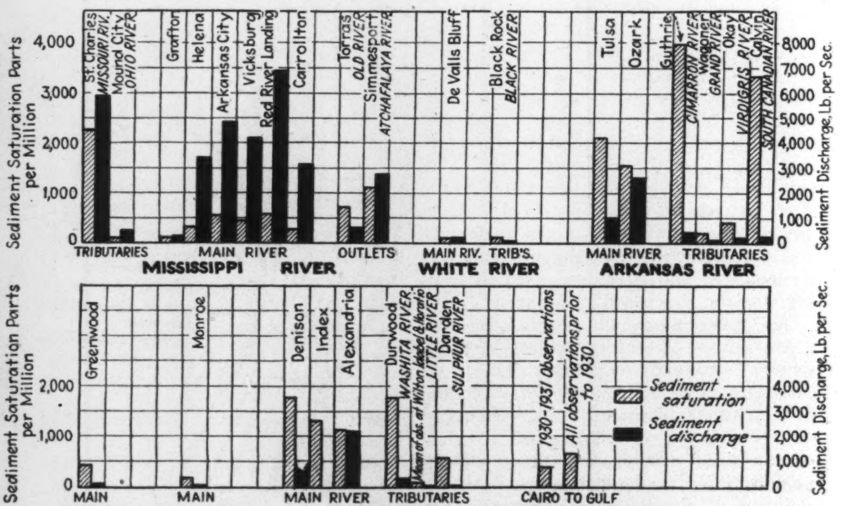
**Fig. 3—Indoor model of Greenville bends, with horizontal scale of 1:4800 and vertical scale of 1:360, showing location of hook gages. At the left, along the wall is the 3½x4x187-ft. permanent steel flume.**

The oat grains that were used to simulate bed-load material pointed the direction of the flow of the subsurface currents by which they were transported. These directions corresponded with those indicated by the colored dyes. From the above it can be seen that the material moved at an angle with the directions of the flow of the currents by which it was transported.

To account for this apparent anomaly, the theory has been advanced that material transported along the bed of a stream tends to move across the section to zones of lower velocity. Since the higher velocities are always found on the deep pool side of the stream, the bed material always manifests the tendency to cross to the zone of low velocity on the convex bank, where a portion of it is deposited in the shape of the customary point bar.

In considering methods for the removal of this material from the channel of the main stream by means of diversion channels, nine different conditions were investigated. These represented diversion channels located at intervals around the bend, on both sides of the stream, and under conditions of both high and medium-stage flow. It was found that, when operated under certain conditions, these channels would be very effective in withdrawing the material. The essential conditions necessary for the removal of any material through the channel are that the channel must be located on the convex side of the stream, and that the velocity through it must exceed the velocity in the section of the main stream immediately opposite the channel. At every stage of a stream there is one critical area on the convex bank in a bend where there is a pronounced tendency toward deposition of material and consequent bar building.

**Fig. 4—Chart showing sediment saturation and discharge at 26 stations where samples were taken in the sediment survey of 1930-'31.**



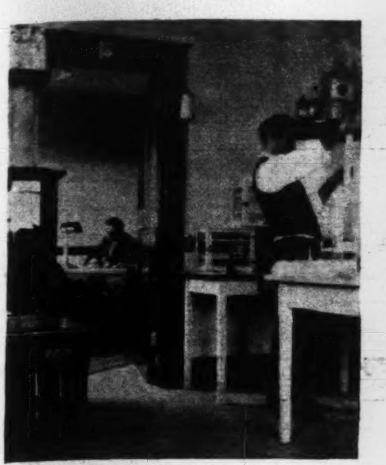


**Fig 5—A glimpse of the laboratory in which the thousands of sediment samples were analyzed and the results computed and recorded.**

At high stages this zone is at its greatest distance downstream; as the stage of flow falls, this focal point of deposition moves upstream. The effectiveness of diversion channels increases with the increase of stage.

At high stages considerable latitude may be employed in the selection of the site for a channel. Conversely, the zone in which efficient channels may be located becomes more restricted with the decline of stages. Channel No. 5, located as shown in Fig. 1, showed the highest efficiency. When the model was operated at the 40-ft. stage, this channel diverted 97 per cent of a measured amount of material. When once removed from the channel of the main stream and passed into a reservoir or basin, the material was immediately redeposited unless the critical velocities were maintained. So long, however, as these velocities were maintained the material was transported along the model floodway.

### Bed-load movement at forks

A series of tests was conducted in the spring of 1933 for the study of bed-load movement at a river fork. Experiments previously conducted for this purpose both in the United States and abroad had failed to take into account material moved entirely through the flumes and lost at the outlet, and they dealt primarily with channels of a rectangular cross-section. The purpose of the experiments conducted at the U. S. Waterways Experiment Station was to determine the division of bed-load material in flumes of semicircular cross-sections.

To reduce the number of tests, one case was studied—namely, that of steeper slopes in the side channel than in the main flume. The division of flow in the two channels was 40 per cent down the side and 60 per cent in the main. It was found that from start to finish of the test about 50 per cent of the sand entered the side channel and was either deposited or moved through to sand traps at the lower end. With sand traps provided to gather and measure all the sand moved through the flumes, it was possible to carry the experiment over a long period of time with correspondingly accurate results.

The figures given above are for a sand of relatively small grain diameter, and as a matter of fact a considerable proportion of this material was carried in suspension. It was found that when a coarser sand was employed, so that the movement was almost entirely by traction along the bottom, a greater percentage was moved into the side channel than previously. In the latter case, with 40 per cent of the discharge in the side channel, nearly 65 per cent of the sand was moved therein. This indicated that for material carried partly in suspension the ratio of diversion becomes more nearly that of the water itself.

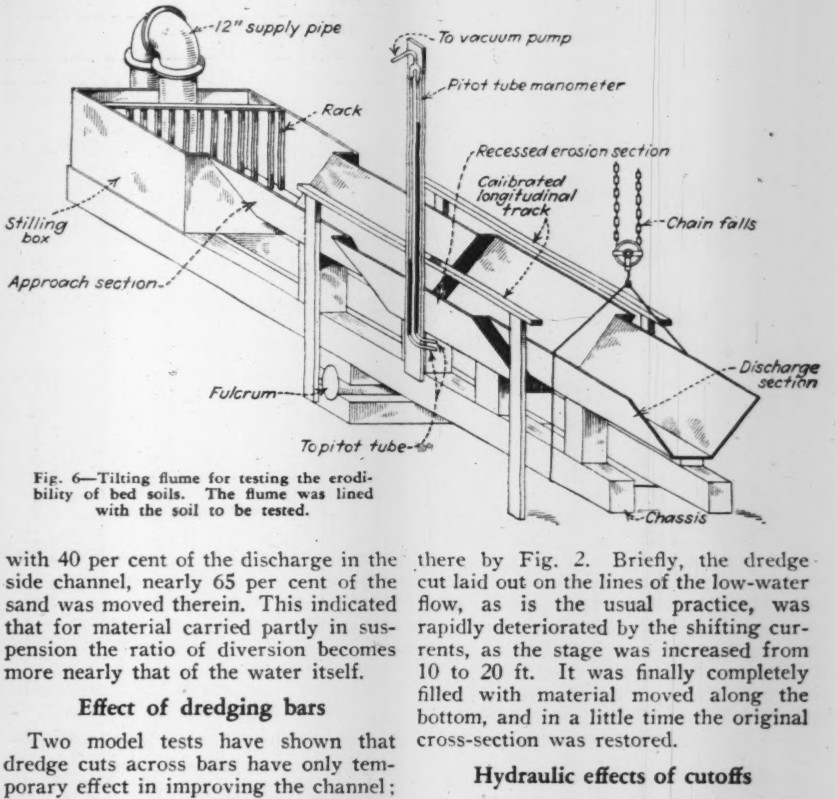


Fig. 6—Tilting flume for testing the erodibility of bed soils. The flume was lined with the soil to be tested.

### Effect of dredging bars

Two model tests have shown that dredge cuts across bars have only temporary effect in improving the channel; the cut is soon refilled by bed-load movement. One of the tests was made on a point bar and the other on a crossing bar.

*Point-Bar Test*—The model was a reproduction of Laconia Bend and had a length of about 2½ miles and a radius of about the same length. It was located between miles 370 and 375. The specific problem was to determine the effect of dredging a bar on the convex side upon a caving bank on the concave side. First, the model was made with a movable bed and a concave bank of caving material; second, it was made with a fixed bed of normal and of dredged sections, and a study was made of resulting change in velocities in the sections.

In the erodible bank runs, little that was definite could be secured on bank erosion; model materials were not found that simulated natural action. However, definite information was secured of bed movement. A bar formed on the convex bank near the head of the bend and moved downstream at a constant rate. The dredge cut was invariably filled, and the old channel re-established itself.

In the fixed bed tests the results showed that dredging the point bar had a tendency to decrease velocities along the concave bank with corresponding increases along the convex bank.

*Crossing Bar Test*—The model and channel conditions were those illustrated and described for model design procedure in the preceding article. The location of the dredge cut was as shown there by Fig. 2. Briefly, the dredge cut laid out on the lines of the low-water flow, as is the usual practice, was rapidly deteriorated by the shifting currents, as the stage was increased from 10 to 20 ft. It was finally completely filled with material moved along the bottom, and in a little time the original cross-section was restored.

### Hydraulic effects of cutoffs

In general, the hydraulic effect of a cut-off is a general lowering of the flow line above the cut-off, and no change in the elevation of the flow line below the cutoff. This conclusion is the result of model studies of ten cutoffs considered in a program of river straightening to eliminate the necessity of the Boeuf floodway, which is included in the official flood-control plan for the Mississippi River. The cut-offs considered were as listed in a preceding article on straightening the river (*ENR*, June 29, page 838). Two sets of models were employed, one as shown by Fig. 3, located in the laboratory (scale l=1:4800, d=1:360), and the other 370 ft. long, located out-of-doors and constructed to scales of l=1:2400 and d=1:120.

The results from the indoor model tests, confined virtually to the river reaches, including the Greenville bends, were summarized in *Engineering News-Record,* July 16, 1931, p. 84. The larger model tests of seven cutoffs below the Greenville bends were conducted individually and in combinations. Based on the tests of all ten cutoffs and with both models, the hydraulic findings can be summarized as follows:

Investigations conducted on the ten cutoffs lead generally to the conclusions that a lowering of stages will result in immediate upstream reaches, while immediately below, except as lowered by the next cutoff downstream, the stages will remain as before.

TABLE I — ERODING VELOCITIES FOR DIFFERENT MISSISSIPPI VALLEY SOILS PREPA ED AND ARRANGED IN DIFFERENT WAYS AS FLUME LININGS

| Number of Test | Kind of Material | Condition of Material as Placed | Slope of Flume | Mean Velocity, Ft. Per Sec. | Botto Veloci Ft. Per |
|---|---|---|---|---|---|
| 1 | Sand | Compacted and inundated for 12 hours. | Level | 1.3 | 1.2 |
| 2 | Loess | " | Level | No erosion | No erosion |
| 3 | Loess | " | Inclined | 4.1 | 3.6 |
| 4 | Loess | Compacted but left dry. | Level | 1.5 | 1.4 |
| 5 | Loess | Natural slabs of loess. | Level | 4.0 | 3.6 |
| 6 | Loess | Compacted, inundated and seasoned. 3 days. | Level | 4.1 | 3.6 |
| 7 | Loess | " | Level | 4.0 | 3.6 |
| 8 | Clay* | " | Inclined | 9.7 | 6.0 |
| 9 | Clay Over Sand | " | Level | (Sand) 2.2 | (Sand) 1.5 |
| 10 | Red Sandy Loam† | " | Inclined | 6.2 | 4.9 |
| 11 | Red Sandy Loam over Sand | " | Level | (Sand) 2.2 | (Sand) 1.5 |

*Sand 20, silt 19, clay 61 per cent. †Sand 39, silt 40, clay 21 per cent.

TABLE II — EROSION TESTS ON CLAY FROM THE BOEUF BASIN, FAIRLY REPRESENTATIVE OF MISSISSIPPI VALLEY CLAYS

(Section of soil 5 ft. long, 0.5 ft. thick on bed and on 1 to 1 side slopes, packed in recessed section of flume. Surface of soil smooth and true to standard flume section. Approach and discharge sections also filled with buckshot clay.)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| No. of Run | Time of Run | Total Time Model Subjected to Scouring, Hours | Depth of Water Over Bed of Sample, Ft. | Mean Velocity Ft./Sec. | Bottom Velocity Ft./Sec. | Condition of Soil After Run. Measured Erosion, if Possible |
| 1 | 30 | 0.5 | 0.3 | 1.92 | 1.8 | No erosion. |
| 2 | 30 | 1.0 | 0.3 | 4.6 | 4.5 | No erosion. |
| 3 | 30 | 1.5 | 0.3 | 6.1 | 5.9 | Very slight pitting in a few places, not measurable. |
| 4 | 30 | 2.0 | 0.3 | 6.6 | 6.1 | Same, but for augmentation of one of the pits. |
| 5 | 30 | 2.5 | 0.3 | 7.2 | 5.75 | Same as 4. |
| 6 | 30 | 3.0 | 0.3 | 7.85 | 6.2 | Two holes started pitting near foot of side slope. |
| 7 | 30 | 3.5 | 0.3 | 8.4 | 5.9 | Same as 6. |
| 8 | 30 | 4.0 | 0.3 | 8.4 | 6.2 | Slightly more erosion than No. 7. |
| 9 | 30 | 4.5 | 0.3 | 9.2 | 5.9 | Slight augmentation of pits. |
| 10 | 1010 | 21.3 | 0.3 | 6.6 | 5.2 | After 16 hr. 50 min. run considerable erosion. |
| 11 | 60 | 22.3 | 0.3 | 5.45 | 3.6 | No new changes. |
| 12 | 60 | 23.3 | 0.45 | 9.75 | 6.75 | Slightly more erosion than previous run. |

TABLE III — RELATIVE ERODIBILITY OF SOILS COMPUTED FROM BOTH LINED FLUME AND CORE TESTS

|  | Vol. Eroded, Cu.Ft. Per Sec. Per Unit of Area at Eroding Velocity | Ratios of Volumes Eroded | Eroding Velocities, Ft. Per Sec. at Bottom | Per Cent Core Loss in 5 Hr. at 2 Ft. Per Sec. Velocity | Ratios of Cone Losses |
|---|---|---|---|---|---|
| Loess (wet compacted) | .000175 | 0.60000 | 3.6 | ........... | ......... |
| Loess (dry compacted) | .000288 | 1.00000 | 3.2 | 6,000 | 1,000 |
| Boeuf clay (3705) | .000000493 | 0.00017 | 6.0 | ........... | ......... |
| Boeuf loam (4200) | .000000918 | 0.00032 | 4.9 | ........... | ......... |
| Boeuf clay (6) | ................. | 0.00039 | 3.0 | 70 | 0.0116 |
| Atch. clay (1) | ................. | 0.00047 | 3.0 | 85 | 0.0141 |
| Atch. loam (2) | ................. | 0.00042 | 3.0 | 75 | 0.0125 |
| Atch. clay (3) | ................. | 0.000365 | 3.0 | 55 | 0.0092 |
| Atch. clay (4) | ................. | 0.000217 | 3.0 | 50 | 0.0083 |
| Atch. clay (5) | ................. | 0.00033 | 3.0 | 60 | 0.0100 |
| Atch. loam (7) | .0000016 | 0.00555 | 3.0 | 1,000 | 0.1666 |

## Sediment investigations

Observations on sediment saturation and discharge have combined a review of previously determined data and a laboratory survey covering a full year (1930-'31) and including records from 26 stations on the Mississippi River and tributaries. The survey data are the most complete and systematic of any ever obtained. Procedure has included methods of taking samples, methods of laboratory analyses and methods of computing sediment content and sediment transportation rate. The results compiled in 26 tables are summarized in the chart, Fig. 4.

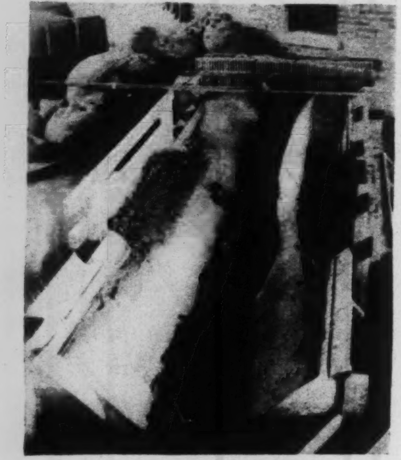


**Fig. 7 — Flume lined with loess. View shows condition of lining after 25-min. run with a bottom velocity of 3.6 ft. per second.**

Sediment samples were all taken under the direction of the engineer districts in which the stations were located. Various forms of sediment traps were employed, but the sampling methods were uniformly as follows: Observation ranges were established across the channels as close as possible to discharge ranges. From a boat, samples were taken at the top, mid-depth and near the bottom at eight points across the channel equally spaced along the range. The eight samples from each depth were then combined to form a composite sample, and the three composite samples were sent to the laboratory where all analyses and computations were performed. A glimpse of the sediment laboratory is shown by Fig. 5.

Laboratory methods and equipment and methods of computing sediment discharge and transportation rates were precise but were kept as simple as possible and extended no farther than accuracy required. In determining ratios by weight of suspended solids to water, both gravitational settlement and filtration were employed, the former most commonly and the latter for certain samples, particularly of water, containing colloids in suspension or containing salts.

## Soil erodibility

Soil-erosion experiments have been conducted primarily to determine the possibilities and rates of channel enlargement by flowing water as in the case of pilot channels for floodways and dredge cuts for artificial cutoffs. The tests were conducted in two phases: (1) the soils in various combinations were arranged as lining of a trapozoidalsection flume, and (2) the soils, cored or molded into cylinders, were set in slaking pans and in a glass-sided flume in which water flowed. The larger flume is shown by Fig. 6, and Fig. 7 shows the manner of lining it with earth to be tested. Except to note that the flume was arranged to tilt to regulate velocities, the illustrations are sufficient.

*Lined Flume Results*—The materials tested and the eroding velocity for each are given in Table I. Comment is indicated only as follows: Test 1 was a flume calibration test to determine if sand-erosion velocities recorded in the flume corresponded with accepted values of velocities of erosion of sand. Close agreement indicated the reliability of the flume. Tests 2 to 7 were made to select a standard erosive material easily obtainable with which the erodibility of other material could be compared. Except in test 2, in which eroding velocities were never developed, and in test 4, where the unnatural condition of subjecting a dry soil to water flow was created, all loess tests show almost exact uniformity of eroding velocities.

The test of particular importance was test 8, in which the material was a fairly typical Mississippi alluvial clay such as occurs frequently and may be expected (indeed has been found in cutoff channel operations) in any considerable channel excavation. Table II shows the results of the clay test; the 16-hour, 50-min. run (No. 10) is particularly to be noted. At the end of this run (20 hours' actual eroding time) the total erosion had been 0.328 cu. ft. The weighted mean of erosive mean velocities was 9.7 ft. a second. In contrast, test 9 (clay overlaying exposed sand) is to be noted; rapid erosion of the sand undermines and breaks down the clay for rapid dispersion by the current. Parallel behavior of the sandy loam (tests 10 and 11) is to be noted, although this material showed much less resistance than clay.

TABLE IV — TRANSPORTABILITY OF SAND AS DETERMINED BY TESTS CONDUCTED IN STEEL FLUME

| Run No. | Depth Water Ft. | Velocity Ft. / Sec. Surf | Velocity Ft. / Sec. Mid. | Velocity Ft. / Sec. Bot. | Distance Carried, Ft. | Percentage of Each Sand Particle Size Transported. (Sizes represent diameters in millimeters.) 0.589 to 0.295 | 0.295 to 0.147 | 0.147 to 0.046 | Silt |
|---|---|---|---|---|---|---|---|---|---|
| | 1.1 | 1.2 | 1.2 | 0.4 | 0 | 13 | 70 | 15 | 1 |
| .. | .... | .... | .... | .... | 40 | 6 | 36 | 55 | 3 |
| .. | .... | .... | .... | .... | 70 | 2 | 8 | 76 | 14 |
| 2 | 0.6 | 3.1 | 2.9 | 2.5 | 90 | 18 | 76 | 6 | .. |
| .. | .... | .... | .... | .... | 125 | 18 | 77 | 5 | .. |
| | 1.0 | 4.0 | 4.0 | 3.3 | No deposit | .. | .. | .. | .. |
| | 1.0 | 4.0 | 4.0 | 3.3 | 140 | 8 | 87 | 5 | .. |
| 5 | 1.4 | 2.6 | 2.6 | 2.0 | 10 | 54 | 42 | 4 | .. |
| .. | .... | .... | .... | .... | 80 | 8 | 80 | 12 | .. |
| .. | .... | .... | .... | .... | 140 | 2 | 66 | 32 | .. |
| 6 | 1.7 | 2.9 | 2.9 | 2.5 | 10 | 66 | 29 | 5 | .. |
| .. | .... | .... | .... | .... | 80 | 40 | 55 | 5 | .. |
| .. | .... | .... | .... | .... | 140 | 6 | 77 | 17 | .. |

*Core-Erosion Results*—Soils selected from the Boeuf and Atchafalaya basins and also standard loess were cored in their natural state, and after remolding the cores were placed in a rectangular flume with a glass window and were subjected to eroding velocities. Out of the many individual phenomena noted the main facts of erodibility are summarized in Table III. The broad fact indicated is the very slow erodibility of the valley clays.

## Transportation and erosion of sand

In connection with general tests on the erodibility of soils, calibrating (Table I) and other flume runs were made on sand beds to determine transportation, scouring velocities and rate of erosion. A sand tested was a representative coarse sand from the Boeuf basin having the following granular composition:

| Diameter, Millimeters | Per Cent Volume |
|---|---|
| Above 0.589 | 2 |
| 0.589 to 0.295 | 50 |
| 0.295 to 0.147 | 38 |
| 0.147 to 0.046 | 9 |
| Silt | 1 |

In the transportation observations, sand was introduced into water flowing in a flume 3x3½x180 ft., while a constant velocity was maintained. On completion of a run, samples of the sand, as deposited in the flume at the distances noted, were collected and analyzed by the sieve method. The results of the observations are given in Table IV.

Scouring velocities, as observed through the glass side of the test flume, developed as indicated by Table V. At positive scouring velocity (2½ ft.) the sand eroded rapidly in swirls and clouds. No bottom movement occurred, the sand particles rising obliquely without rolling. The rate of erosion was determined to be 0.0177 ft. per minute. Velocities of 1.7 ft. per second did not produce measurable scour in 15 min. Where the test was repeated at a velocity of 2.1 ft., it was found by measuring the sand deposited along the flume bottom that 28 per cent of the apparent scour was through suspension. From this the positive erosion was determined to be 0.0067 ft. per minute.

TABLE V — CRITICAL SCOURING VELOCITIES FOR SAND AS DISCLOSED BY FLUME TESTS

| Run No. | Depth Water, Ft. | Velocity Ft. / Sec. Mid. | Velocity Ft. / Sec. Side Bot. | Velocity Ft. / Sec. Cent. | Velocity Ft. / Sec. Aver. | Remarks (Sand is brown and fine) (Depth = 35.1 ft.) |
|---|---|---|---|---|---|---|
| | 0.8 | 1.4 | 1.1 | 1.2 | 1.2 | Slight rolling of smaller sand grains on bottom. Slight bottom scour. |
| 2 | 0.68 | 1.7 | 1.35 | .... | 1.5 | Steady, but shallow bottom. |
| 3 | 0.6 | 2.0 | 1.6 | .... | 1.8 | Scour, slight suspension. |
| 4 | 0.35 | 2.2 | 1.8 | .... | 2.0 | Bottom movement, better suspension. |
| 5 | 0.50 | 2.3 | 1.9 | .... | 2.1 | Bottom movement increased slightly. Good suspension. |
| | 0.8 | 2.7 | 2.4 | .... | 2.5 | Positive suspension. Sand washed up and away in clouds. Bottom movement negligible. |

TABLE VI — RATE OF EROSION OF SAND AS DETERMINED BY FLUME TESTS

| Run No. | Length of Run, Min. | Velocity, Ft. Per Sec. Mid-Depth, Cent. | Velocity, Ft. Per Sec. Bot. Side | Velocity, Ft. Per Sec. Bot. Cent. | Velocity, Ft. Per Sec. Aver. | Water Depth, Ft. | Scour Aver. Depth, Ft. | Scour Rates, Ft. Per Min. | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .. | 2.9 | 2.1 | .... | 2.5 | 0.8 | ..... | ...... | Extremely rapid positive erosion. |
| .. | .. | 2.65 | 2.0 | .... | 2.3 | .... | ..... | ....... | Sand had wind-blown effect. |
| .. | 10 | 2.65 | 1.9 | .... | 2.2 | .... | 0.188 | 0.018 | |
| .. | .. | 1.2 | 1.6 | .... | 1.4 | 0.7 | ..... | ...... | Wave motion, sand rolling along bottom. |
| .. | ... | 1.8 | 1.8 | 1.8 | 1.7 | 0.6 | 0.0 | ...... | Slight clouding. |
| .. | 25 | 2.0 | 1.9 | 1.95 | 1.7 | 0.5 | ..... | 0.0 | Waves smoothed out. |
| | | | | | | | | | Steady, slight scour. |
| 3 | .. | 2.2 | 1.8 | 2.2 | 2.1 | 0.8 | ..... | ....... | Rapid bottom movement. |
| .. | 15 | .... | .... | .... | .... | .... | 0.036 | 0.0067 | 28 per cent of eroded material in suspension. |

* * *

## Roadbuilding Program for Argentine Republic

The General Direction of Roads, recently organized as an autonomous government office by the Argentine Congress, has published its plan for the building of a national system of roads, of which 18,000 miles will be built within the next fifteen years, spread over the several states and territories of the republic. Of these roads, 1,200 miles will be concrete, 3,800 miles macadam and 13,000 miles ordinary earth road. The total cost is estimated at 600 million paper pesos, or about $240,000,000.

To finance this construction, various forms of taxes have been increased, including the tax on lubricants, net earnings of railroads and on real estate.

During the year 1933 a total of 40,000,000 pesos will be spent, 18,000,000 of which will be contributions to local roadbuilding of states and towns as one-fifth of their total outlay.

Copies of a report on the plan are on file in the Bureau of Foreign and Domestic Commerce, Washington, D. C. The report is divided into sections covering highway problems, general highway plan, construction in 1933, regulations governing federal aid, traffic census, and traffic relations.

# Building a Steel Shelter Over Casa Grande Ruins

## Adequate protection provided for famous ancient structure in Arizona—Architectural problems and structural design—The steel roof frame, 98x82 ft., was erected over old shelter roof

By F. A. Kittredge and Edward A. Nickel
*Chief Engineer and Associate Structural Engineer, Respectively, National Park Service*

MANY NOVEL engineering problems are encountered by the National Park Service in preserving and making accessible the ruins of past civilizations to the public. The value of these ancient structures or their ruins cannot be estimated in terms of money, but they constitute one of the important historic assets of the country. Such a ruin is the famous Casa Grande in Arizona. The design of a suitable protecting shelter for this "Great House" provides the subject for the present article. Architectural requirements created special problems in planning the 98x82-ft. roof supported on four unbraced columns. Many readers will recall the two previous stories by Mr. Kittredge, on the Kaibab Bridge (*ENR*, Jan. 9, 1930, p. 56) and the Carlsbad Cavern elevator (*ENR*, June 9, 1932, p. 821). The present work further exemplifies the picturesque problems and work of the National Park Service. —EDITOR.

UNIQUE problems in structural design and construction were involved in providing a steel shelter roof to protect the Casa Grande ruins in the Casa Grande National Monument, Ariz. Serious deterioration of the 30-year-old temporary roof and the importance of this famous ruin among the historic assets of the country led to planning the protective structure.

As consideration had to be given to architectural requirements, the structural design centered around the conditions defined by the chief landscape architect, and at the same time had to provide necessary strength against winds. The main construction problem was the protection of the ruins during the dismantling of the old shelter and the erection of the new roof. The cost of the project was about $27,700 and has effected a permanent protection for this important historic monument.

*History*—The Casa Grande or "Great House" is located 57 miles south of Phoenix and 65 miles north of Tucson, Ariz., on the main highway connecting the two cities. It was built by the Indians some 800 years ago and was first recorded in history by Padre Kino, a Spanish missionary, in 1694. He described it as "a four-story building as large as a castle and equal to the finest church in these lands of Sonora." The structure is now in ruins, without roof or floors, but the existing walls are of such interest that it is visited and described more than any other prehistoric ruin in the Southwest.

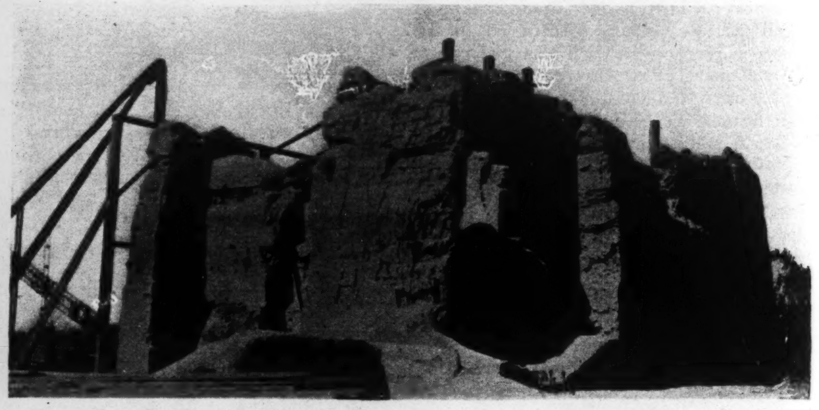


Fig. 1—Casa Grande ruin, 800 years old, is the most famous prehistoric structure in the Southwest. It is built with 4-ft. adobe walls, the central section is four stories in height.

In common with many of the other houses in the vicinity, Casa Grande was built of adobe, or, to be exact, of caliche, the local name given to a stratum of soil generally found about 4 ft. below the surface and very rich in lime content. The structure, about 58x42 ft. in plan, comprises five rooms on the ground floor. The center room is four stories high, and the outside walls forming the other four rooms are three stories high. The walls are monolithic, unreinforced and have a maximum thickness at the base of 4 ft.; they are battered, and at the floor levels are offset, reducing the wall thickness to 18 in. at the top.

In 1903 a temporary wood frame with corrugated-iron roof covering was built over the ruins by the government, at a cost of $2,000. Deterioration of this structure, in both the wood frame and the corrugated-iron covering, had progressed to the point where it was necessary to replace it with a shelter of more permanent construction. In 1932, at the urgent request of Horace Albright, director of National Park Service, sufficient funds were appropriated by Congress for this work.

*Architectural Requirements*—Fro the architectural viewpoint it was de cided, after studying many types o design using structural frames of stee reinforced concrete and combinations o both, that the lighter appearing stee frame would detract and dwarf the ruin less than a more massive structure o concrete. The general type of struc ture finally selected was suggested b F. L. Olmstead, landscape architect, Boston, and was developed in the sketch stage by the landscape division of the National Park Service. The preliminary design indicated four steel columns guyed by rods at the quarter, half and three-quarters points to the main trusses, but the subsequent study resulted in the elimination of the guy rods.

Protection of the ruins had to be considered in the structural design, details, specifications and supervision of construction. All the work of dismantling the old protective cover and constructing the new protective cover was done by contract force account under the direct supervision of the engineering office of the National Park Service. The design, to meet the peculiar requirements, had to give attention to proper height of steel frame above ruin walls, size of roof to give adequate protection and good appearance, strength sufficient to resist wind pressure and uplift, column anchorage to resist overturning, lightning protection of the steel frame,

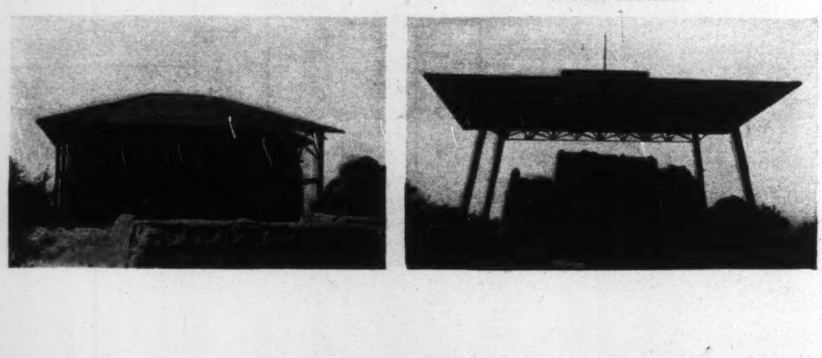


Fig. 2—The first protection (left) after 30 years' service has been replaced with a permanent covering (right) designed with architectural treatment to leave the view of the ruin unobstructed, provide ample light and not detract by blending with the ancient structure.

skylights, and proper roof drainage.

For hundreds of years the Casa Grande ruin has been subject to wind and water erosion. Photographs taken in 1892 and again in 1932, when the cover had been removed, did not show an indication of substantial erosion during the 40-year period. However, shortly after 1892 extensive restoration and protective work was carried out both near the base of the ruins, and in 1903 the protective roof was built, fitting tightly over the top of the ruin in order to protect the exposed eroded edges of the top of the walls. The present new roof is higher, having been designed to provide an unobstructed view of the ruin; it is impossible to predict what may be the erosive or abrasive action of the wind and sand on the walls or within the rooms as the result of the change in air currents effected by the new covering.

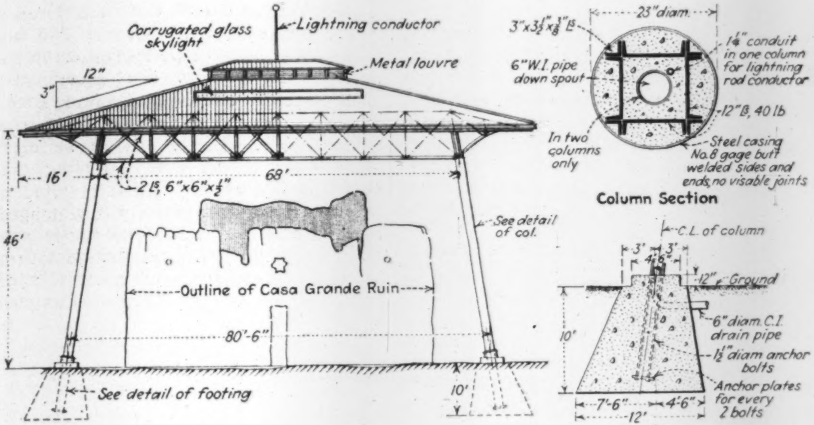


**Fig. 3—General structural features and details of the Casa Grande shelter.**

*General Design*—The height of 46 ft. from the ground to the cornice of the roof was selected as giving the desired clearance of about 10 ft. above the walls of the ruin, the architectural aim being to have the walls silhouetted against the sky and mountains rather than against the background of the artificial protection. In plan the roof is 98x82 ft., giving a 20-ft. overhang beyond the walls of the ruin.

In keeping with the architectural plan for providing a frame of light appearance to contrast against the ruins, all of the structural members were designed for appearance as well as strength. Angles were used in the chord members instead of channels, and the short leg was placed vertical to expose the smallest area of steel to view. Whenever possible, the same size of member was used, with a view to symmetry and attractiveness. All structural details were carefully studied to make each joint as pleasing as possible. The ends of all angle members were cut to make neat connections, and all the gusset plates were kept to a minimum.

*Wind Requirements*—Reports of the Weather Bureau at Phoenix indicated that desert thunder storms and sand storms give a probable maximum wind velocity of 40 to 50 miles an hour for 5-min. intervals, but the bureau recommended a higher value for the Casa Grande site. A possible velocity of 70 miles per hour was assumed. This is equivalent to 20 lb. per sq.ft. of vertical projection in accordance with Marvin's formula for wind pressure. To provide for gusts and for the added effect of partial vacuum on the lee side, the wind pressure for design was doubled to 40 lb. per sq.ft. of vertical projection. This is equivalent to a storm of hurricane proportions. All structural members were designed for this pressure in addition to dead load. No other live-load condition was considered. As a check on the maximum dead and live-load stresses obtained for this loading, a dead and live load of 45 lb. per sq.ft. was assumed and the stress was computed for all members. These stresses in many cases were greater than the combined stress due to dead load and wind load and were used accordingly.

*Structural Details*—The four concrete footings were designed to support the dead load of the structure and also to provide sufficient weight to resist the lifting and overturning moment caused by a wind acting parallel to the diagonal axis of the structure. Each footing is 6x6 ft. in area at the top, 12x12 ft. at the base and 10 ft. deep, weighing about 68 tons. The columns are attached to the footings by eight 1½-in. bolts, and the anchorage is designed to resist the moment of the horizontal wind force applied at the point of inflection of each column.

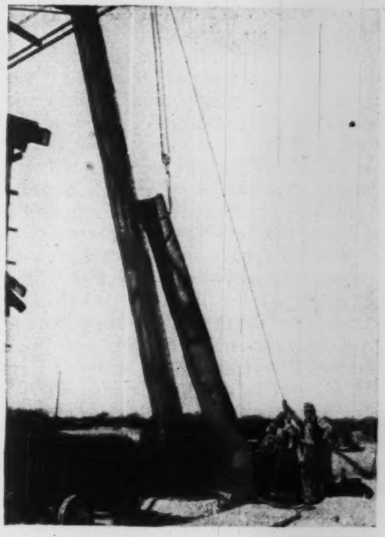
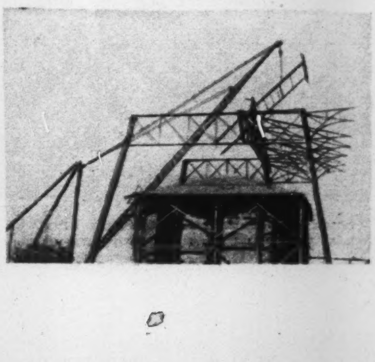


**Fig. 4—The four structural columns are incased in cylindrical steel covers set up in half sections and later filled with concrete. Downspouts are carried inside these columns.**

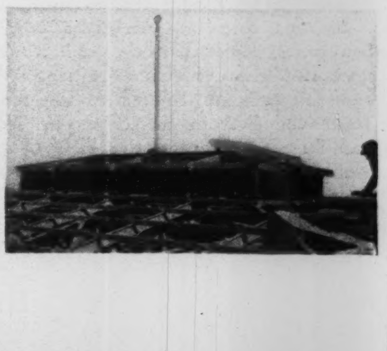
**Fig. 5—Erection of the 114 tons of steel was completed in seven days in spite of extra precautions to protect the ruin from damage. One set-up of the 110-ft.-boom stiff-leg derrick was used.**



Steel columns made up of four 12-in. 40-lb. channels and four 3x3x½-in. angles were required to resist the wind moment, the main trusses being considered as portal frames. Each column weighed slightly more than 6 tons.

To obtain the round column effect desired by the landscape architect, the structural columns were incased with a cylindrical steel shell made up of No. 8 gage iron. This casing was delivered to the job in sections of half-column height and one-half the circumference. Held together by straps during erection, the joints were later arc-welded and then ground smooth by an air-driven emery wheel. Finally the casings were filled with concrete.

**Fig. 6—The roof covering is of asbestos-cement sheets with the exception of four large corrugated glass skylights. The louvre is to reduce upward wind pressure, and the lightning protection was required by the exposed position of this steel structure.**



All trusses are of the double Warren type with an over-all height of 10 ft. All members are built up of angles, and the total weight of the two longer trusses was about 6 tons. Rafters consisted of 8-in. I-beams spaced at 8 ft., and a 12-in. I-beam connecting the ends of all rafters formed the eave or cornice beam. Purlins, designed for a normal load of 30 lb. per sq.ft., are 4-in., 6.25-lb. channels at 3-ft. spacing.

The roof covering selected was corrugated asbestos-cement board. Sheets were called for in 42-in. widths, with a 4.2-in. depth of corrugation, and weighed about 4.1 lb. per sq.ft. This material is sufficiently strong to span 51 in. and is usually fastened every 18 in. along purlins by means of ¼-in. bolts and J-clips. As a special precaution, because of the exposed condition of the roof, the purlin spacing was reduced to 3 ft. and the roofing sheets were fastened at 12-in. intervals.

Four corrugated-glass skylights, 6x16 and 6x32 ft., were placed in the roof to light the ruins, which during the summer months would have been shaded because of the overhang of the shelter. The glass is in 28x40-in. sheets fastened by brass bolts and clips and flashed between sheets and on the sides with copper for watertightness.

Because of the exposed position of this high isolated steel frame it was necessary to provide lightning protection. An 8-ft. hollow steel tube fastened securely to the ridge was provided with a 2-ft. vertical section of Bakelite tubing topped by an 8-in. Monel metal ball. An insulated conductor of ⅜-in. stranded copper cable passed through the tube from the ball, along the lower flange of one of the 9-in. hip rafters, down the column, through the footing and attached to a 22-gage copper plate 1 yd. square placed 15 ft. below the ground surface. This copper plate was buried in a mixture of charcoal and rock salt. As an additional precaution, permanent dampness was provided by running a 1-in. water-service pipe to the location and providing for a continuous drip. In addition to the main lightning conductor and ground, each steel column was grounded by means of a ⅜-in. bare copper conductor from the base of the column to a copper plate.

A ventilator was placed at the ridge of the roof to relieve the possible suction caused by an upward wind pressure. Copper louvers were placed in the openings. The dimensions were 32 ft. long, 10 ft. wide and 32 in. high.

Arizona rains are occasionally very heavy for short periods, and it was necessary to provide roof drainage sufficient to prevent damage to the ruins from water from the eaves or from capillary action near the base of the walls. An 8x10-in. copper gutter was placed around the eaves connected to two 6-in. copper downspouts that lead to two 6-in. iron pipes placed inside two of the columns. These downspouts connect to two vitrified-clay drain pipes that carry all water to a low point removed from the ruins.

*Construction* — Construction operations involved the dismantling of the old roof and the erection of the new one. The specifications were particularly strict with reference to damaging the ruins, the surrounding low ruin walls or the shrubbery. The first step was to remove the old corrugated-iron roofing and replace it with a heavy timber cover to protect the ruin during construction operations. This work was done under the direct supervision of the engineer, and no damage to the ruin resulted.

A stiffleg derrick with a 110-ft. boom operated by gasoline hoist was the principal piece of construction equipment, and practically all material for the structure was raised and placed from one setup. A 100-cu.ft. compressor was also used. Raising of the 114 tons of steel required only seven days with a crew of twelve men. Two riveting crews completed the field work in seven days. Steel and material was trucked to the site 2½ miles from Coolidge, Ariz.

At the completion of construction work the protective wooden covering was removed. This required extreme care because it was impossible to use the construction equipment available a the beginning of the work. Final removal of the cover was done by hand using only block and tackle.

Horace M. Albright is director of the National Park Service and in general charge of all activities. Engineering work is under the supervision of F. A Kittredge, chief engineer, and architectural controls were presented by T. C Vint, chief landscape architect. Edward A. Nickel, associate engineer, was in direct charge of structural design and construction.

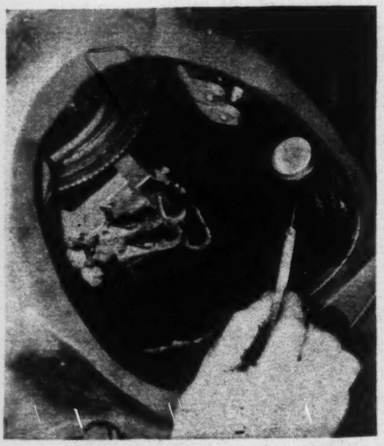
The engineering department wishes to acknowledge the splendid assistance of Frank Pinkley, superintendent of Southwestern monuments, and Hilding Palmer, custodian of the Casa Grande ruins, under whose approval and administrative control all operations in the national monuments are coordinated. The general contractor, Allan Bros., Inc., Los Angeles, and their superintendent, Mr. White, are to be commended for the care used during construction operations, which resulted in leaving the ruins entirely undamaged. Steel fabrication was done under subcontract by the Virginia Bridge & Iron Works. Excavation and concrete work was handled by the Clinton Campbell Co., Phoenix.

# Thermostatic Heat Control for Power-Shovel Motors

**By J. E. Borland**

*Mining Engineer, Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.*

ELECTRIC-SHOVEL motors have three possible operating conditions that make the problem of overload protection extremely difficult — unusually hard digging with high motor currents, clogged ventilation or failure of blower motor if force-ventilated, and the possibility of a high ambient temperature. The primary consideration is to be certain that the total temperature inside the motor is below the point at which the insulation will be damaged. Motors are rated on a basis of a certain temperature rise, and whether they will be damaged by excessive overload depends to a considerable extent on the ambient temperature, type of insulation, method of ventilation and other indefinite conditions.



**Small thermostat mounted on the interpole winding of d.c. machines warns the operator of dangerous temperatures.**

Overload protective devices commonly used for industrial work are not suitable. Because of this, variable-voltage power shovels are made more or less self-protecting by applying generators with poor voltage regulation—i.e., as the current increases, the voltage decreases. Under ordinary conditions this inherent limiting of the maximum current is sufficient, but a recent development making possible the mounting of a small thermostat directly on the motor gives much more complete overload protection than has ever before been possible.

The thermostat may be connected in the control circuit to stop the motor automatically when it approaches a dangerous temperature, or, as might be preferred by the average operator, the thermostat may merely work a signal warning the operator of an excessive temperature.

Maintenance and shutdown cost for repairs can probably be greatly reduced by this system of temperature indication or control.

# Materials and Specifications Discussed by A.S.T.M.

## Corrosion of metals and facts on bituminous materials, timber, masonry, cement and concrete contributed to proceedings of Chicago convention

*Engineering News-Record Staff Report*

THE PRESENT ARTICLE concludes the report of the annual meeting of the American Society for Testing Materials, begun in the issue of July 6, p. 170. —EDITOR.

IN THE DISCUSSION of corrosion of metals at the annual meeting of the American Society for Testing Materials, held at Chicago June 26-30, it was reported that the several long-time corrosion investigations being carried on by Society committees have gone ahead. Inspections last fall and this spring of the iron and steel sheets suspended in sea water at Annapolis revealed new failures, all due to perforation and fringing along the bottom edges. In the total immersion tests the 22-gage sheets at Key West, Fla., and Portsmouth, N. H., have all failed; but until the 16-gage sheet tests are completed no conclusions will be drawn by the committee. The subcommittee investigating galvanized sheets exposed at Altoona, Pa., Sandy Hook, N. J., Key West, Fla., and State College, Pa., presented a comprehensive progress report, whose conclusions confirm those previously drawn—namely, that the relative resistance of zinc and iron to corrosion varies with location; also that the durability of a zinc coating is proportional to the weight of the coating.

A progress report on corrosion tests of iron chromium and other alloys was accompanied by a paper on such tests of stainless alloys. The committee on corrosion of iron and steel recommended adoption as standard of the present tentative specifications for galvanized telegraph and telephone wire, wire strand and wire-mesh fencing. Another progress report was made by the committee on corrosion of non-ferrous metals and alloys. Revised specifications for zinc coating or hot-galvanizing on structural steel were submitted, and a report was presented on the hot-galvanizing of pipe and fittings.

### Timber

Several revisions of timber specifications were adopted. The revisions in the standard specification for structural joists, beams, posts, etc., involved a more detailed and broader classification of thicknesses and the introduction of dressed sizes and tolerances. The subcommittee in charge of this work also reported additional work in connection with the timber-pile specification. An attempt is being made to broaden the specification to include piles for lighter bridges and buildings.

Investigation of the moisture content of timber is being continued. It has been established that it is possible to determine approximate average moisture content of heavy timbers by inserting a pair of electrodes to a depth of about one-fourth the thickness of the timber.

### Bituminous materials

Work on accelerated weathering tests of bituminous waterproofing and roofing materials has continued, resulting in a proposed test. New information was reported regarding the radiant energy of the two types of lamps that have been used in the work.

A paper by Gene Abson (Chicago Testing Laboratory) described a method and the apparatus for recovering asphalt from pavements for test purposes. Briefly, the asphalts are extracted with benzol, which is in turn removed by distillation in an atmosphere of carbon dioxide at comparatively low temperature, thus eliminating the danger of hardening of the asphalt, which is common to the usual methods of distillation at high temperatures.

### Unit masonry

The session on unit masonry—brick, hollow tile and mortars—was one of the most productive of the entire meeting. Weather resistance of brick masonry, strength tests of reinforced-brickwork beams and a report on permeability of brick-masonry walls were outstanding. The committee on hollow masonry building units secured several revisions in standard specifications of structural clay tile; the changes include limitation of shell thickness and a change in classification. "Hard" and "medium" types are to be known henceforth as "16-6," and "soft" types as "16-25"; the two figures are respectively the minimum and maximum average absorptions of five tests. The committee on clay pipe asked that standard specification C13-24 be withdrawn because the new specification C13-32T will be advanced to standard just as soon as some of the differences between it and the federal specifications can be ironed out.

J. W. McBurney (Bureau of Standards) reported on an extensive investigation of strength, water absorption and weather resistance of building brick in the United States. Some 480 specimens have been subjected to 51 cycles of freezing and thawing. About 37½ per cent of the U. S. production was represented in the samples. For purposes of test and study the country was divided into districts producing similar type of brick. Tables in the report give data for the thirteen largest cities of the country. So far as compressive strength was concerned, Pittsburgh and St. Louis were highest, with slightly over 11,000 lb. per sq.in. Chicago was near the bottom, with an average compressive strength of 3,450 lb. per sq.in. For the United States as a whole the range in compressive strength is from 1,500 to 21,000 lb. per sq.in., and in five hours' boil the range in water absorption is from less than 2 to 34 per cent. Shale brick had a narrower range for all properties than clay brick.

A careful test program carried out on 8x12-in. reinforced brick beams at the University of Wisconsin was reported by Prof. M. O. Withey. The make-up of the beams was notable in two particulars. No headers were used in the top course, where heavy compressive stresses occur, and Z-stirrups were utilized. The outstanding legs of these stirrups were staggered, permitting a better spacing (one-half the effective depth of the beam) than with U-stirrups. Loads were applied at the third-points of an 8-ft. span. Coefficients of resistance ($M/bd^2$) in excess of 500 lb. per sq.in. and maximum shear stresses in excess of 200 lb. per sq.in. were obtained. Maximum values were 840 and 294 lb., respectively. One of the most urgent necessities demonstrated by the tests is that all joints must be completely filled; no grooving must be permitted. A mortar of 1 lime: 3 cement: 12 sand proved very satisfactory. Professor Withey mentioned the following problems that need study: effect of duration of load on strength and stiffness, resistance to freezing, thawing and fire, practical types of web reinforcement and utilization of thin keyed tile in place of the bottom course of brick.

In discussion, A. E. Anderegg stated an opinion that steel reinforcement in brick beams is not sufficiently protected by the mortar. The opposite opinion was expressed by numerous others present, who pointed out that mortar for reinforced brickwork must be of highest quality and that the dirty sand mortars prevalent in plain brick-masonry construction must not be allowed.

An unusually stimulating paper was given by Prof. W. C. Voss (Massachusetts Institute of Technology), who briefly reviewed a two-year investigation of permeability of brick walls, presenting an interesting hypothesis regarding the formation of a "bond layer" between the mortar and the brick. Professor Voss' studies show that brick and mortar types must be correlated for best results; a dense brick and a dense mortar do not necessarily produce a watertight wall. The studies indicate that a brick should absorb from 5 to 10 per cent of its weight in water in 48 hours and that it should absorb this water at a low rate after the first 5 or 10 minutes. These characteristics allow the mortar to build up an effective bond layer. Lime is required to supply the materials necessary for this action and a good mortar is composed of 1 part cement, 1 part lime and 5 to 6 parts sand by volume. The bond layer is formed by the movement of the moisture in the mortar toward the brick. The movement must neither be retarded nor accelerated too much by the respective qualities of the brick or the mortar. The mortar needs to be so constituted as to allow dissolution and recrystallization at the plane of the brick. The brick should approach in its expansion or contraction that of the substances in the bond layer. Studies of thin sections of joints under the petrographic microscope revealed some facts about the bond layer, but according to Professor Voss they are far from conclusive. The layer probably contains calcium in the form of a hydroxyl or carbonate rather than in the form of a silicate.

Mr. McBurney questioned a number of the tentative conclusions, in particular pointing out that most bricks have a total absorption in excess of the 10 per cent maximum set by Professor Voss.

Prof. R. E. Davis (University of California) stressed the importance of the fineness of the mortar materials as a factor in securing watertight joints. Also, low-volume change is imperative, and for this reason rich mortars are of questionable value. The committee on mortars has organized seventeen subcommittees and is attempting to secure funds to carry out a review and correlation of existing data so that a comprehensive investigation may be mapped out.

### Cement and concrete

The last day of the convention was largely devoted to the subject of cement and concrete. The cement committee has functioned since January under its new reorganization plan, which places a sponsoring committee of four members in charge of each cement specification. There are also working committees of three members to be assigned to specific problems. The principal recommendation of the committee, namely that the tentative specification for high-early-strength cement be advanced to standard, was defeated by a vote of 21 to 18.

P. H. Bates (Bureau of Standards) in an important paper on the status of hydraulic cement specifications suggested that the cement committee recognize the need for several kinds of cement for various uses and also look into the adequacy of some of the specified test methods. Mr. Bates used the Boulder Dam cement as an example of a special cement for a special need. He also pointed out that the present definition of standard portland cement implies that cement containing sand or iron oxide is not portland cement. Specifications should limit $SO_3$ and MgO, but do not do so. Attention should be directed toward new methods of measuring fineness, since the No. 200 sieve is about obsolete. Mr. Bates emphasized the importance of a compression test, such as the plastic mortar cube. In conclusion he tentatively recommended that specifications be prepared for several cements. Five of these should exhibit respectively the qualities of high-early strength, plasticity, low heat of hardening, low volume change and resistance to moisture. In addition two other cements should be similar to present standard portland except that one should be lower in lime and higher in silica than the other. J. C. Pearson (Lehigh Portland Cement Co.) stated that manufacturers would not be averse to any reasonable changes in specifications, but pointed out that of the cements suggested by Mr. Bates only two can be recognized using existing methods of test.

A paper describing tests on a blended cement using a siliceous material in the form of a volcanic ash was contributed by R. W. Carlson and G. E. Troxell (University of California). Volume change, heat of hydration and compressive strength were examined. In general, volume changes were shown to be lower at early ages and higher at later ages than for plain cement. High-lime cement of the blended type had the least tendency toward increased contraction at the later ages. Blending reduces the heat of hydration, but not by the full percentage of the cement replacement. The secondary compressive strengths of mortar made of blended cement were lower than those of plain cement mortar, but at 28 days the strengths were more nearly equal. As much as 30 per cent of the silica could be added to a high-lime cement without reducing the three-month mortar strength, the authors concluded. T. C. Powers in discussions pointed out that the volcanic ash used is one of the most active of silicas, which may account for the good results reported in the paper.

Determination of distribution of particle size of cement is one of the most important present-day requirements. L. A. Wagner (Cement Reference Laboratory) exhibited an apparatus consisting of a light of constant intensity, the beam from which is passed through a cement sample suspended in kerosene and directed onto a photoelectric cell which measures in microamperes the light that passes through. By an ingenious mathematical method microamperes are converted to specific surface. It is claimed that the apparatus can determine the distribution down to particles of $7\frac{1}{2}$-micron size. In effect the apparatus is a photo-electric turbidimeter.

An investigation carried on at the University of Michigan of a large number of commercial cements, in an attempt to determine a relation between cement constituents and mortar durability was reported in a paper by Prof. C. H. Hughes. So far as resistance to artificial freezing and thawing is concerned, the tests revealed that tricalcium silicate is the most desirable constituent and $C_4AF$ the least desirable.

Two papers bearing on Boulder Dam investigation work were presented—"Fabricating Large Concrete Cylinders," by R. F. Blanks and E. N. Vidal (Bureau of Reclamation), and "Calorimeter Apparatus," by S. B. Biddle, Jr. and J. W. Kelly (University of California).

One of the most important events of the convention was the presentation of a report by Committee C-9 on the significance of tests of concrete and concrete aggregates. R. W. Crum, chairman, briefly reviewed the report, which consisted of some 15 papers, each devoted to a specific test. A. N. Talbot introduced the report by a general and pointed survey of the place and purpose of tests. Tests, he said, are essential to specifications laid down to insure proper conduct of vital commercial transactions. Tests are of three kinds—acceptance, informational and investigational. None of them is infallible, some are carelessly made, and all need to be examined carefully in the light of advancement of knowledge.

As to concrete, the report covered the following subjects: compressive strength, D. A. Abrams; tensile and transverse strength, A. T. Goldbeck; shearing strength, A. T. Goldbeck; elastic properties, F. E. Richart; durability tests, C. H. Scholer; resistance to abrasion, C. H. Scholer; workability, J. C. Pearson; volume changes, R. E. Davis and J. W. Kelly; uniformity, R. L. Bertin; routine analysis of cement content of hardened portland cement concrete, H. F. Kriege.

Aggregates were dealt with under the following heads: gradation, specific gravity, unit weight and voids of concrete, Fred Hubbard; deleterious substances, F. C. Lang; soundness of aggregates, Stanton Walker; free moisture and absorption, Bert Myers; abrasion tests of aggregates, H. F. Clemmer; mortar-strength tests of fine aggregates, F. H. Jackson; number of specimens or tests required for resonable accuracy of the average, R. W. Crum.

In so far as specifications are concerned, the most significant action affecting Committee C-9 was withdrawal of its proposed tentative specification for light-weight aggregates as incomplete.

### Pavements

The committee on road and paving materials secured adoption of a tentative specification for concrete for pavements. The specification is the result of almost two years of work on the part of a subcommittee.

Further results on the tests conducted by the Bureau of Public Roads on full-size concrete pavement sections were reported in a paper by F. H. Jackson and W. F. Kellerman. Effect of vibration during the finishing operation and a method of delayed finishing for removing excess water, known as the Johnson method, were described. Earlier tests determined quite definitely that concrete with a slump of less than 2 in. cannot be placed satisfactorily with common methods. However, with vibrators mounted on the finishing machines it is possible to place 1-in. slump concrete. Considerably more coarse aggregate also can be included when vibrators are used. Vibration increases the flexural strength of the concrete.

With the Johnson method the pavement was floated and rolled and belted, after which a dry mix was applied, consisting of 1 part cement and 1 part of fine sand. After an interval of time varying from 10 to 50 min. the slabs were again belted and floated until moisture could not be brought to the surface. All slabs finished by this method showed higher crushing and flexural strength than pavement finished by standard methods.

# Technical Discussions at Civil Engineers' Convention

## Meetings of eight technical divisions covered a wide field, in which taxation and structural theory were prominent—Water hammer, traffic studies, city development and pollution of natural waters among subjects discussed

***Engineering News-Record Staff Report***

THE FIRST PART of our report of the A.S.C.E. meeting at Chicago during Engineers' Week, June 26-30, appeared July 6, pp. 20 and 21. —EDITOR.

FOR adequate appraisal of the scope of the technical activities at Chicago during the busy "Engineers' Week" of June 26-30, and the bearing of these activities on the meeting of the American Society of Civil Engineers, it is necessary to call to mind the range of engineering societies that met in Chicago during the same week. They included a conference of general contractors on the subject of industry codes, convened by the Associated General Contractors; a meeting of the Producers' Council; meetings of the Construction League and of its policy committee; sessions of the governing bodies of the American Road Builders' Association; a meeting of the engineering section of the American Association for the Advancement of Science; conventions of the National Council of State Boards of Engineering Examiners, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Society for the Promotion of Engineering Education, the American Foundrymen's Association, the Society of Industrial Engineers, the American Society for Testing Materials, and others; and finally meetings of numerous committees of national importance. In the civil engineers' program advantage was taken of the presence of these other societies to conduct a number of intersociety technical sessions.

### President's address

Alonzo J. Hammond in his presidential address compared the state of the art a century ago and now. Water transport was then in the ascendency. The 350-mile Erie Canal, the Welland Canal and the Ohio Canal completed in 1833 established a complete waterway from New York to New Orleans. The first part of the 30 miles of railroad in the country had just been built in New Orleans, using the first T-rails. He compared the corduroy highways of the 1830's with the smooth ribbons of today, the 10,000,000 total hp. in all prime movers of 1849 with the billion now, the 44 waterworks of 1830 with the more than 10,000 of today, and so on through bridges, dams, locks, sewerage systems, sanitation and vertical and horizontal city development.

### Can taxes be brought down?

The economics and finance division of the society chose tax reduction as the subject of most timeliness to be discussed at its session. Four principal speakers took part: E. P. Goodrich, of New York; Frank Bane, director of the American Public Welfare Association, Chicago; Luther Gulick, director of the Institute of Public Administration, New York; and C. E. Rider, recently controller of the city of Detroit. The final conclusion was that no great reduction in total taxes paid by any individual may be expected. Reductions that may be made will come from administrative economies and not from wiping out any large group of expenditures because, with the exception of those made for war purposes, governmental expenditures are for necessities such as public health, education, welfare, etc.

Mr. Goodrich could see little likelihood of reduction of federal taxes because of the tendency of the federal government to take over or increase its supervisory powers over private enterprises, as exemplified by land reclamation, the building of the Panama Canal, flood control and the setting up of the Federal Reserve system. These operations together with the increase in population have caused the number of federal employees and thus the total of expenditure to mount rapidly. Mr. Goodrich suggested the possibility of limiting expenditures to a fixed percentage of income as a tax-reduction measure, but admitted that in many ways this is impractical.

Mr. Bane pointed out how 43 state legislatures have tried to reduce taxes this year, without any notable success. Savings in education, which accounts for 40 per cent of state expenditures, can be made only by reducing teacher's salaries, selecting children, reducing the curriculum or curtailing the building program. Welfare, which accounts for 21 per cent of expenditures, will not humanely admit of any reduction. Highways, representing 18 per cent of expenditures, can provide a saving, but reducing highway work increases welfare and relief demands.

Mr. Gulick, though concurring in the opinion that total taxes can hardly be reduced, urged large reductions in state expenditures by transferring them to the federal government, where many of them belong. In his opinion the states cannot regulate banking, transportation, insurance and similar activities. Governmental control, which includes planning and tax systems, must be set up on the basis of economic areas, and the United States as a whole is such an area, while the individual states are not.

Mr. Rider discussed municipal taxes. In his opinion, the depression has made most cities reduce expenditures so substantially that further attempts at reduction would be unwise.

What can the engineer do to assist in improving government operation? The question was asked, and a number of answers were given. Closer cooperation with the layman to the end that his support be enlisted for worthy expenditures was one. Adopting a broader viewpoint of public-works expenditures and studying their future implications as well as their present advantages was another. The engineer can go much farther in giving cities professional advice on long-time planning, and he can take a more active part in actual government.

### Highway economics

More economics and less emotionalism with reference to roads is one way to keep highways sold to the public, the highway division was told by E. J. Mehren, president of the Portland Cement Association. He suggested that the state highway departments are the logical agents to do this publicity work. A man with the public-relations viewpoint is needed who can train members of the staff as public speakers. Collateral organizations, such as the motor clubs, service clubs, chain store organizations, gas and oil industries and bus operators, are willing to help but need guidance.

R. W. Crum, in discussion, said that the Highway Research Board has taken up the determination of comprehensive data on annual costs, which are badly needed.

Ralph Budd, president of the Chicago, Burlington & Quincy R.R., indicated that too much propaganda now is directed by highway and railroad advocates against each other rather than toward the economics of the whole transportation problem so as to utilize the most efficient plant at least cost. Common ground should be sought on which all can agree, especially with reference to rates and services of trucks, regulation and taxes.

### City planning and construction

Slum-clearance problems were discussed in the city planning division by John Millar, of *Millar's Housing Letter*. Obstacles to action are lack of public opinion, too few facts, limited legislation, land speculation, lack of financial support. He forecast better social control through better environment. F. L. Ackerman explained how, in his opinion, blight comes about largely through poverty, so that slum clearance is poverty clearance. Arthur W. Consoer, consulting engineer, Chicago, said that little can be accomplished until taxing bodies base valuations on rent or other income.

Hugh E. Young, engineer of the Chicago Plan Commission, described six of the 76 city plan projects carried out by Chicago and analyzed their value from the humanitarian and commercial standpoints. U. N. Arthur spoke similarly for Pittsburgh. State and regional planning was discussed by J. L. Crane, particularly the work of Iowa in getting factual data and an appraisal of the natural resources and an agricultural survey. Minnesota, Wisconsin and Michigan have also made progress in statewide surveys. In Wisconsin the Fox River Valley has been surveyed somewhat on the same basis as the Tennessee Valley. Rural Oneida County, Wisconsin, is zoned with agricultural, forestry and recreation allocations.

Russell Van Nest Black stressed the desirability of a pay-as-you-go policy in flush times and the use of credit even to a reduction of taxes in depressions. He is against long 20- to 50-year planning except as mental exercise, 5 to 10 years being the practical length of program that can be effectively set up.

Reviews of 100 years of progress in different lines characterized the papers at the meetings of the construction division. Progress in transportation facilities was dealt with by Col. F. G. Jonah, chief engineer of the St. Louis & San Francisco Railway; and in water transportation by J. H. Gardner, president of the Society of Naval Architects and Marine Engineers. Bridge design and construction was reviewed by O. H. Ammann, chief engineer of the Port Authority of New York. Evolution from the Indian's plow to modern excavating and concreting machinery in the construction of irrigation canals and dams was reviewed by Elwood Mead, U. S. Commissioner of Reclamation. Of a somewhat different character was a paper by S. A. Greeley, Chicago (and read in his absence), on changes in municipal facilities, with diagrams of wages and the varying costs of sewers, cast-iron pipe, reservoirs and the Chicago water tunnels.

More directly related to construction methods was a review of "A Century of Construction Machinery," by F. C. Ruhloff (Bucyrus-Erie Co.). Developments in the construction of industrial buildings, of steel and concrete, were outlined by T. L. Condron (Chicago). Possibilities rather than past developments were dealt with by Paul E. Sabine (Riverbank Laboratories) in a paper on sound control in buildings of the future.

### Surveying and mapping

Reviews of survey methods during the past 100 years, both urban and rural, formed the topic of one of the two sessions of the surveying and mapping division. Land-surveying problems occupied the attention of the division at the second session.

A resolution called on the board of direction to urge President Roosevelt to carry out the recommendation of the federal board on surveys and maps, which relates to consolidation of all governmental agencies having to do with the various forms of surveying and mapping. Another resolution, to be sent to divisions of the federal government and to state highway departments, requested that particular care be observed during construction of public-works projects to save section corners.

### Stream pollution

A comprehensive review of the vast project of the Chicago Sanitary District for the treatment of the city's sewage and the relation of this treatment to the condition of the Illinois River was given by Langdon Pearse, sanitary engineer for the District. Five major items originally planned have been reduced to three: the North Side plant, the West Side plant and the Calumet plant. This last, with Imhoff tanks, reduces the suspended matter 39 to 43 per cent, but its extension will be on the activated-sludge system. It is considered doubtful as to how far treatment should go for the purpose of reducing pollution in the Illinois River, but removal of sludge is essential, as there are evidences of sludge deposits above the dams. Storm overflow methods are still uncertain and will require careful control, while use of the river flow for power purposes by the state is another factor in the problem.

The importance of sludge deposits in their effect on dissolved oxygen content of the river water was noted in a discussion by Harrison P. Eddy. Almon L. Fales discussed the general problem of stream cleansing. Dr. Buswell, chief of the Illinois State Water Survey, suggested an investigation of the plan proposed by the Chicago Sanitary District for sewage dilution. Benefits to public health resulting from the removal of filth from Lake Michigan were noted briefly by George W. Fuller. Reduction of pollution in the Sangamon River, as the result of the construction of the sewage-disposal plant at Decatur, Ill., was described by W. D. Hatfield, superintendent of the plant.

Industrial wastes badly complicate the problems of water purification and sewage disposal at Duluth, Minn., according to John Wilson, city engineer. Numerous sources of pollution occur on the St. Louis River above the city, and both sewage and wastes pass out to pollute the waters of the bay and Lake Superior. Chlorination is the only protection of the city's water, which is drawn from the lake. Plans for sewage-treatment works are being considered, but treatment of the wastes is to be left to the industries. Brief particulars of the proposed plants were given by L. R. Howson.

The long-standing, often-described, but still unremedied, severe pollution of the south end of Lake Michigan, with its occasional invasion of the zone of the Chicago water intakes, was described by Arthur E. Gorman, engineer of water purification, and John R. Baylis, chemist, of the Chicago water department. The relation of wastes to pollution of the lower Fox River and the plans and methods provided for eliminating this pollution were described by L. F. Warrick, state sanitary engineer of Wisconsin.

### Waterways and hydraulics

Col. Daniel I. Sultan, district engineer, U. S. Engineer Office, Chicago, speaking before the waterways division, described the Chicago Terminal of the newly-opened Lakes-to-the-Gulf Waterway, stressing the latest views of the War Department to the effect that the Calumet-Sag Channel entrance is more desirable than utilization of the Chicago River.

By moving-pictures, D. L. Yarnell (U. S. Bureau of Agricultural Engineering) and Floyd A. Nagler (University of Iowa) presented the results of experiments on the flow of water around transparent pipe bends in which short strands of wool yarn suspended on wires showed current directions. It was found that the loss of head is greatly influenced by the degree of uniformity of flow approaching the bend, which fact accounts for the discordant results of previous experimenters. When water approaches a bend with uniform velocity, a double spiral flow results in the bend. division.

If the velocity is high at the bottom, the double spiral disappears and a single spiral filling the whole section takes its place. If the velocity is high at the top, the spiral takes the opposite direction. Flow conditions are best with high velocity approaching the outside of the bend, while with high velocity approaching the inside of the bend the maximum of disturbance and loss of head results.

### Water hammer

A symposium on water hammer occupied two full sessions. On this subject the knowledge, experience, writings and research are widely scattered and divergent; extremely complex and necessarily highly mathematical in treatment, it requires extensive experimental demonstration.

S. Logan Kerr, chairman, reviewed the present status of the various theories. The report contains a bibliography and a recommended code of symbols for formulas to encourage uniformity and comparability in mathematical treatment.

The leading paper was presented by A. W. K. Billings (Brazilian Traction, Light & Power Co.) in conjunction with O. H. Dodkin, F. Knapp and Adolpho Santos, Jr., engineers of the São Paulo Tramway, Light & Power Co. The problem was attacked from many sides, revealing much new research and analysis. It proposed for consideration as theoretically correct a radically new principle of design, with the penstock expanding toward the turbine instead of contracting.

Walter Dreyer presented the water-hammer analysis of the Drum and Tiger Creek plants of the Pacific Gas & Electric Co., and Robert E. Glover (U. S. Bureau of Reclamation) analyzed the problem in compound pipes as applied to Boulder Dam. Water hammer and surge control in pump-discharge mains were treated by Ray S. Quick (Pelton Water Wheel Co.). He also described a new relief valve. Mr. Kerr described its application to the Croton Lake pumping plant and the water-hammer tests that followed in demonstrating the apparatus.

### Suspension-bridge and other structural theory

Two papers discussing the theory of suspension-bridge analysis were presented at one of a series of joint sessions of the structural division with the A.S.M.E. applied mechanics section. The first, by D. B. Steinman (New York), set forth a generalized deflection theory and some application results. While the other, by A. A. Jakkula (University of Michigan), compared various methods of mathematical solution of the basic suspension-bridge equations.

Dr. Steinman extended the so-called exact or deflection method of analysis, which as he stated has been known for many years but has been in form suitable only to non-continuous spans, to bridges with continuous stiffening trusses and to multiple-span bridges. The lower stresses that the method gives, as compared with the approximate or "elastic method," are thus made applicable to types of suspension bridges hitherto built with excess truss material (continuous-truss bridges) or avoided (multiple-span structures).

Applying his formulas to a continuous-truss bridge of 800-ft. main span, Dr. Steinman found truss stresses 45 per cent less than with the elastic theory, a reduction substantially the same as in case of non-continuous truss types. Using the method to make a specific comparison of 800-ft. continuous and non-continuous construction, he found a truss saving of 5 per cent for the former as against the latter, and concluded that continuous construction is the more economical for highway spans up to 1,000 ft. and railway spans up to some higher limit.

William G. Grove (New York) described the main features of design and construction of the Sky Ride, the long-span cable railway that is one of the attractions at the exposition. The all-rope suspension system between the towers differs in some respects from the original project (*ENR*, Aug. 11, 1932, p. 172). Mr. Grove's paper was followed by descriptions of other design elements and construction operations by I. F. Stern, E. T. Blix (Mississippi Valley Structural Steel Co.) and C. M. Jones (John A. Roebling's Sons Co.).

Several papers of essentially mathematical character were also discussed in these joint sessions: "Graphostatics of Stress Functions," by Prof. H. M. Westergaard (University of Illinois); "Amplitudes of Non-Harmonic Vibrations," by Prof. J. P. Den Hartog (Harvard University); "Stability of Thin-Walled Tubes Under Torsion," by Prof. L. H. Donnell (California Institute of Technology), who also exhibited views of experimental checks on the theory made on tubes of various diameter length ratios; "Impact Effect on Bridges," by Prof. R. Bernhard (Germany); "Stability of the Web of Plate Girders," by Prof. S. Timoshenko (University of Michigan); and "Rational Design of Steel Columns," by D. H. Young (University of Michigan).

Prof. James J. Ryan (University of Minnesota) exhibited an instrument for recording the lateral and torsional vibrations of structures or machines. It combines detecting elements of seismograph type with optical indication and recording by a beam of light reflected from a rotating polygon of mirrors upon a glass screen or a film.

### Concrete arches and wind in buildings

The second session of the structural division brought out a new research report on the concrete-arch investigation at the University of Illinois and two papers in the field of wind design of buildings. Prof. W. M. Wilson reported the results of tests on nine concrete arches, each with three 27-ft. spans on piers 10 to 20 ft. high, tested with the rib alone and with deck. Decks were tested first with expansion joints over the piers and at the third-points and then with the third-point joints eliminated. Abstract of this important paper must be reserved for a future issue. Briefly, thrust lines were found to follow the axis of the ribs closely under all conditions of loading; the results gave support to the accepted elastic theory as a suitable design method; all failures of the rib were caused by flexure; and elimination of the third-point expansion joints increased the rigidity of the deck appreciably. Deck interaction reduced the moment in the rib at the spring line and increased it at the middle of the span.

In a discussion of the investigation Prof. Hardy Cross expressed the opinion that it is much more important to eliminate secondary stresses in concrete arches than to develop fine theoretical means to evaluate them. Accordingly, a flexible superstructure has distinct advantages. Searcy B. Slack (Georgia) pointed out the need for field studies on concrete arches, particularly with reference to long-time temperature affects. Model studies of the Illinois arches were discussed by Prof. George E. Beggs. In conclusion, Professor Wilson stated that the research work is continuing, with emphasis on the question of the relief of live and dead-load stresses by time yield of the concrete.

A paper on wind pressure on buildings by O. Flachsbart (Germany), which was read and discussed by Prof. R. H. Sherlock (University of Michigan), presented a theory that takes aerodynamic and aerologic factors into consideration. The view was expressed that present wind-design methods ignore many facts well known to aeronautical engineers and especially the presence of high negative pressures on any object placed in a wind stream. Albert Smith (Chicago) supported the author's views on negative pressures, pointing out the great influence of shape of building on wind-pressure effects.

Tests of split H-beam wind connections, using four, eight and sixteen rivets, were reported by Prof. W. C. Huntington (University of Illinois). The sixteen-rivet connections were found to waste the value of many of the rivets. The four and eight-rivet connections were better, but the inner lines of rivets carried the greater part of the load. F. W. Dencer (American Bridge Co.) stated that most designers prefer two- and four-rivet connections. Albert Smith expressed the belief based on study and experiment that a sixteen-rivet connection has a value of nine and one-half rivets and a four-rivet connection of about three rivets.

# Engineering News-Record

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## Work Well Done

ON JUNE 30 the National Committee for Trade Recovery closed its New York office and, while its state committees will carry on, the cessation of centralized activity means that an important chapter in the construction industry's record of service has come to an end. The committee was established fourteen months ago, to promote a national re-employment program of public-works construction. Seemingly hopeless obstacles had to be faced, among them banker and industrialist antagonism as well as apathy and discouragement on the part of local governments. Nevertheless the committee, adopting principles similar to those which *Engineering News-Record* had long upheld, went courageously at its task, in order to reopen the country's factories and mercantile establishments for normal functioning by restoring the unemployed workers' purchasing power. Cooperating with professional and industrial groups, it labored indefatigably to assure passage of the Emergency Relief and Construction Act of 1932, and later of the present Recovery Act. Through active state committees it helped local governments to develop their work projects under these acts and rallied public spirit to fight against depression. It did its work well. Its success is reflected in the present countrywide action to get construction going under the Recovery Act; what remains is in the hands of the Washington government. The committee's achievements merit public appreciation, and the men and organizations behind it, including the Construction League, its sponsor, may justly take pride and satisfaction in the results of their labors.

## A Local Problem

HOUSING for the lower groups of wage-earners is a national problem, but except for its broad general aspects it must be solved locally. This fact was emphasized time and again at the meeting last week in Cleveland of the National Conference on Slum Clearance. So long as discussion was confined to questions relating to a definition for slums, to the necessity for fitting slum clearance into a city plan, to general requirements of light, air and room sizes and to the ratio of buildings to open courts and lawns, the conference made progress. But when someone from New York or Chicago injected rents into the picture and characterized as low-cost housing that renting for $10 to $12 per room per month, the conference ceased to be national and ceased to be effective. Such figures are meaningless in Cincinnati, Cleveland, Louisville or Kansas City. They do not in fact represent low-cost housing in New York. If we really are sincere in wishing to give present slum tenants more decent quarters in which to live, $5 and $6 rents must be aimed at. In some cities this perhaps can be done without tax exemption. In others it is out of the question without much larger state and municipal subsidies than have heretofore been considered. The problem of slum clearance in any individual city is a local one, and it cannot be solved or even aided much in detail by national assemblies. Their function is to lay down broad general principles. Any city officials interested in slum clearance or low-cost housing of any kind should examine the proceedings of the convention in Cleveland with that idea in mind. For their own local slum-clearance problems they must use the general findings in the light of local limitations if the result is not to be misleading.

## Gas-Tax Diversion Opposed

THE DECISIVE VOICE with which California voters expressed disapproval of a proposal for gas-tax diversion should be a sober warning to administrations in other states. Even though the proposal was for paying interest on old highway bonds and therefore not strictly outside the field of highway activity, the public demanded that gas-tax revenue be maintained exclusively for its intended purpose—the constructing and maintaining of highways. Although the vote was "for the purpose of ascertaining the wish of the people" and does not necessarily bind the legislature at its session after the present recess, it is inconceivable that a three-to-one voice of the people will be disregarded. For those states where gas-tax diversion has been strictly a legislative procedure without an expression of public opinion the California vote should be a clear indication that such diversion is contrary to the wish of the taxpayer.

## Professional Codes

PROSPECTS of early acceptance of one or more codes for the construction industry bring into focus the correlation of professional activities with certain vital steps in the operations of that industry that have been under active discussion recently. Bid-shopping and chiseling are practices whose damaging effect on sound construction method is well recognized, and in these the engineer or architect is often a direct or indirect participant. As an extreme statement, indeed, it might be said that primary power to curb or wipe out chiseling lies in the engineer's hands, and likewise that he can do a great deal to encourage the practice. If this is true, even in part, there is reason to question whether contracting-code rules designed to do away with shopping and chiseling can be fully successful unless they enlist professional cooperation. Amplification of professional-practice codes to cover the appropriate objectives of contracting and related codes therefore suggests itself as an early desideratum. The same process, perhaps, could be extended to assure equitable regulation of conditions of engineering employment and related matters that affect the sound conduct of professional activities themselves. Factors of the cost of engineering service and means for assuring that engineering engagements will be adequately carried out are as yet by no means placed on a clearly defined basis. A strong enforceable professional code would serve to this end; and if the machinery of the industry control act provides effective means for enforcement, the professional man probably need have no fear that the term "industry" would detract from his standing.

# The State Held Responsible

THROUGH the Supreme Court's decision of several weeks ago (*ENR*, May 25, 1933, p. 696) the financial difficulties of the Sanitary District of Chicago have been laid, by the highest legal authority, on the doorstep of the state of Illinois. The court's ruling, rich in implications as to state responsibility for local government activities, enlarges the decree of three years ago that limited the diversion of Lake Michigan water through the Chicago drainage canal. It now orders the state of Illinois to "take all necessary steps, including authorizations or requirements, or provisions for the raising, appropriations and applications of moneys" in order to complete an adequate system of sewage disposal for the district.

When the court issued its original decree (April, 1930), gradually reducing the amount of water the Sanitary District could divert from the lake for sewage-flushing use, the rate of reduction was predicated upon an active, continuous program of sewage-plant construction by the district, a program that was to be completed before 1939, by which time the diversion would be reduced to the nominal amount of 1,500 sec.-ft. Since the date of the decree the district has fallen on evil days, however. Taxes could not be collected in sufficient amount, existing bonds went into default, further borrowing became impossible, and in consequence the district's construction program came to a standstill more than a year ago. In October, 1932, the other states bordering on the Great Lakes, which had brought the original action against the district, complained to the court that the decreed construction program was not being lived up to, and applied for the appointment of a court officer to execute the decree. A special master was appointed to conduct hearings in the case and to submit his recommendations to the court. The present ruling of the court is made in the light of that report.

Responsibility for righting the mess is unequivocally placed upon the state of Illinois. The district is recognized to be at the end of its rope financially, but is not itself held responsible for the halting of the work; the court finds that "the state of Illinois, by virtue of its status and authority as a state, is the primary and responsible defendant." All authority for the actions of the district is derived from the state, and the state therefore must recognize its ultimate responsibility for accomplishing the ordered reduction in diversion.

Little imagination is needed to see how many applications might be made of this principle in the near future. New York State, for example, might be charged with ultimate responsibility for ending the littering of New Jersey beaches by sea-dumped garbage from New York City. Every local community that infringes interstate or general public rights might be held to become the ward of the state which created it, in respect to the obligation of abating the infringement. The duty placed upon the state to see that its subdivisions and agencies live up to their commitments and responsibilities emerges very clearly from the rule adopted by the court. And particularly in view of present day stream-pollution problems, involving localities in different states, the importance of the rule can hardly be overemphasized.

Another striking part of the court's finding has to do with its own power to order the construction of sewage-treatment plants. In defending its position, the Chicago Sanitary District argued that the court could not go farther than to enjoin continued diversion. The court refused to grant this argument, holding that the delay allowed the district in reducing the amount of diversion was based on the program of sewage-plant construction proposed at the time of the original decree. It was not because of lack of authority to do so that the court omitted specific requirements as to the measures to be taken to make the reduction safe for the health of the district's residents. On the contrary: "In deciding this controversy between states, the authority of the court to enjoin the continued perpetration of the wrong inflicated upon complainants necessarily embraces the authority to require the measures to be taken to end conditions, within the control of the defendant state, which may stand in the way of the execution of the decree." This frank and open avowal of the power to assure constructive action in the correction of interstate wrongs is history-making.

Quite as significant as any other element of the decree, particularly in this time of state and municipal worries about finances, is the court's summary dismissal of the plea of poverty on the part of a great and wealthy state. In no uncertain terms the court declares, "Despite existing economic difficulties, the state has adequate resources, and we find it impossible to conclude that the state cannot devise appropriate and adequate financial measures to enable it to afford suitable protection to its people to the end that its obligation to its sister states, as adjudged by this court, shall be properly discharged." And in order to remove whatever doubts might still remain as to its meaning, the court quotes a passage from the opinion rendered by Justice Holmes in the original diversion case: "It [the state] can base no defenses upon difficulties that it has itself created. If its constitution stands in the way of prompt action, it must amend it or yield to an authority that is paramount to the state." The state thus is viewed not merely as a political mechanism but as a whole community. Responsibility passes beyond the legislature and governor to the people, to the taxpayers and bond buyers. Political handicaps are irrelevant, for "The state has adequate resources."

Fortunately, questions of culpability, responsibility and financial invalidism may all be made of secondary importance by the operation of the federal Recovery Act. There can be no question now as to the necessity of building sewage works in Chicago. The program presents a prime opportunity for federal financing, money grant or outright construction when the public-works administration swings into action in its war on depression. Chicago, the lake states, the unemployed and the country's entire economy will all be benefited by such a course. Thus, the early progress of the Sanitary District's great program of sewage-treatment construction may be held to be assured.

Regardless of emergency action, the practical effect of the Supreme Court's decision is to put in force new principles of state and municipal relations. A workable reality is impressed on the theoretical guardianship of the state over its subordinate units. In this sense the decision parallels the action taken by several states within recent years in setting up means to exercise supervisory responsibility over their cities. Manifestly, where municipal administration makes a failure, the state should take control in the interests of its own citizens; its power to do so can not be questioned. The Supreme Court now adds that where outside interests are affected it has not only the power but the legally enforceable duty to provide remedies for municipal failure.

# NEWS OF THE WEEK

## Ickes and Waite Head Public Works Under Recovery Act

HAROLD L. ICKES, Secretary of the Interior was appointed Administrator of Public Works by President Roosevelt on July 8 to relieve Donald H. Sawyer, temporary administrator, and on July 11, Secretary Ickes announced the appointment of Henry M. Waite, former general manager of the Cincinnati Union Terminals Co., as assistant administrator. It is expected that Col. Sawyer will be retained by the administrator in an executive capacity.

With Col. Waite as a deputy, Secretary Ickes will function both as administrator and as chairman of the Public Works Board, of which Col. George R. Spalding is a member. Retention of the services of both Waite and Spalding is taken in Washington as evidence that President Roosevelt was prompted wholly by political pressure in throwing down the preliminary organization built up by Col. Spalding for the purpose of launching the public works program immediately upon the enactment of the law.

The delay caused by the switch in the administrative set-up was further aggravated by the temporary character of Col. Sawyer's organization and the final decision to set up a regional rather than state system of decentralization. Instructions intended for administrators have been rewritten twice but are expected to be ready when appointments are announced.

### Work to be speeded

Upon taking office Secretary Ickes described the objective immediately ahead as follows:

Swift translation of the Administration plan into action, giving millions of jobs to workers now unemployed.

Permanent organization of the federal emergency administration of public works at once on a decentralized basis to deal intelligently with the difficult task.

"Recent gratifying gains in industry and employment do not justify curtailment or slowing up of the employment programs until those gains are secured and consolidated," Mr. Ickes said. "When conditions justify, expenditure for public works will be ended promptly.

"The nation is assured its funds will not be dissipated on a first come first served basis. Projects for which loans are sought must be backed with facts and specifications able to stand the strict examination they will receive.

"Loans to local governmental bodies where ordinary current expenditures are not being brought within prudently estimated revenues will not be forthcoming. The Government expects its loans to be repaid.

"Shortly machinery for distribution to non-federal projects will be set up permitting allotments with strict protection for the funds granted.

"Many technical problems are arising and difficult decisions must be made. No political pressure or appeal will influence those making the decisions."

### Federal allotments

Allotment to the Department of Commerce of $10,000,000 from the public works fund has been requested by Secretary Roper, a member of the Public Works Board. Secretary Roper regards the function of several agencies in his department as so closely related to public works as to entitle them to participate in the huge emergency program. New projects planned by the Commerce Department total $7,611,477, distributed as follows: Coast & Geodetic Survey $3,500,939; Bureau of Lighthouses $2,333,068; Bureau of Fisheries $1,072,470; Bureau of Standards $430,000; and Bureau of Mines $275,000. Reconditioning work totals $3,259,120, distributed as follows: Bureau of Lighthouses $2,283,920; Aeronautics Branch $487,500; Bureau of Fisheries $230,000; Bureau of Standards $148,500; Coast & Geodetic Survey $79,200; Bureau of Navigation & Steamboat Inspection $30,000.

The proposed allotment to the Commerce Department has not been approved by the Public Works Board and it is probable that the figure will be reduced considerably. Secretary Roper contends, however, that the expenditure proposed is for useful and valuable work that will create employment.

### Loans for local work

In amplification of Secretary Ickes statement that the government expects all loans to be repaid, the public works board has announced that it expects all loans for state, county and municipal work to be repaid, with 4 per cent interest, within the life of the project, but in 30 years in any event. The board has not defined its policy on housing and private projects, but discussion favors housing at low rentals to people of moderate income. Robert D. Kohn, former president of the American Institute of Architects, will have charge of housing and subsistence homesteading. The board has not arrived at any plan for administering the $25,000,000 fund that is available under the law as loans for the purchase of homesteads by families in which the wage earner is employed only part of the year in his trade.

The $400,000,000 road fund has been allotted among the states and in New York, Massachusetts, Ohio and Utah may be converted into contracts shortly as these states have been authorized by the public works board to go ahead pending final approval of their plans. The board has requested the Bureau of Public Roads to submit maps with all state programs for the purpose of revealing whether such separate programs form a coordinated interstate network.

### Federal projects approved

On July 12 the special board for public works approved a list of federal projects totaling $66,000,000 selected from the lists of projects submitted to it by the several governmental departments and agencies.

## Engineers Sought For Design of Federal Buildings

CIVILIAN engineers and architects are to be employed to the greatest extent possible on federal building work under the Recovery Act, according to an announcement made by L. W. Robert, Jr., Assistant Secretary of the Treasury. This policy applies to all federal buildings, the design and construction of which come under the authority of the Supervising Architect's Office of the Treasury.

### To spread employment

Mr. Robert states that for the purpose of spreading employment as far as possible among architects and engineers who, preferably, have had some previous experience in public building work, he has requested the cooperation of American Engineering Council and the American Institute of Architects in enrolling qualified individuals and firms. His purpose is to engage on every building architects and engineers resident in the state in which it will be erected.

The Treasury Department, with the cooperation of the American Institute of Architects, is assembling the records of architects throughout the country.

As the procedure adopted for enrolling architects could not be utilized satisfactorily to obtain the same character of information concerning engineers, the American Engineering Council has been requested by Mr. Robert to compile state lists of engineers and engineering firms that customarily engage in construction of building of the monumental character usually typifying those built by the federal government.

Through its member-organizations and other technical groups, Council inaugurated its canvass several weeks ago. The lists are being prepared so that Council will be in a position to submit to the Treasury Department the names of competent engineers in any and all states when there is a call for the services which they are qualified to render.

### Lists being compiled

Any qualified engineer desiring to participate in the Treasury Department's building program should send to L. W. Wallace, Executive Secretary, American Engineering Council, 744 Jackson Place, N. W., Washington, D. C., a complete statement, in duplicate, of his professional record, with a citation of significant references.

American Engineering Council's function in enrolling engineers for the building program is to make available lists of competent engineers and firms and not to select and employ men.

American Engineering Council is cooperating with Assistant Secretary of the Treasury, Mr. Robert, and the American Institute of Architects in making available to private engineers and architects construction work done under the direction of the Supervising Architect's Office.

## A. P. Davis Named Consultant to Bureau of Reclamation

Arthur Powell Davis has been appointed consulting engineer in the Bureau of Reclamation. In announcing the appointment Secretary Ickes said that Mr. Davis' chief problem will center upon the Boulder Dam project.

Mr. Davis was for years associated with the studies and investigations of the Colorado River basin which led to the selection of the site where the dam is now being built as the best place to regulate and conserve the flow of the Colorado River.

After a number of years with the Geological Survey and the Nicaraguan Canal Commission, Mr. Davis was appointed a principal engineer in the Reclamation Service following the passage of the Reclamation Act in 1902. In 1917, when the Reclamation Service was made a separate bureau of the Department of the Interior, he was appointed chief engineer, and in 1914 became director and chief engineer.

Mr. Davis left the Reclamation Service in 1923 when the post of director was abolished. He was succeeded by D. W. Davis, former Governor of Idaho, as head of the service.

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## California Vote Defeats Gas Tax Diversion By 3 to 1

A proposal for the diversion of gas tax revenue in California was turned down by a majority of almost 3 to 1 at a special election June 27, which also decided several other issues of interest to the construction industry. The proposed diversion would have taken about $17,000,000 of the gas tax funds during the next biennium and transferred it to the general fund to pay interest on outstanding highway bonds voted before the gas tax was put in effect. Thus, although the plan did not involve diversion outside the highway field, the voters foresaw the establishing of a precedent for further diversion and an immediate curtailment in highway activity, which resulted in the decisive defeat. The vote was "advisory" but from the overwhelming sentiment expressed the legislature should be definitely deterred from putting through the proposed diversion.

Nearly 150 state highway engineers and draftsmen have been called back to work, following the defeat of the gas tax diversion proposal and the federal government's decision to allocate nearly $60,000,000 in federal aid funds to California.

Race track betting was approved at the election and as a result preliminary announcement has already been made for the construction of a $1,000,000 horse racing plant near Los Angeles.

A measure was approved which permits the assessors of Los Angeles and Orange counties (the area effected by the Long Beach earthquake) to take into consideration the earthquake damage in assessing for the present year. According to the state constitution assessments are to be based on the value of property as of the first Monday in March. The earthquake occurred a few days later and assessors were unable to take into consideration the fact that some of the assessed property had been destroyed. The emergency act will permit assessment on the basis of property value on the first Monday of July.

A $20,000,000 unemployment relief bond issue was voted which will enable the state to secure further Federal aid for this purpose. It is to be given to counties on the basis of their need and ability to pay.

A measure to authorize the issuance of state bonds up to $55,000,000 to refinance irrigation and reclamation districts failed to carry. It would have provided for a resurvey by the state of any district, upon request of the district, to determine its present ability to pay and the fixing of a price for the redemption of the outstanding bonds. If the district then approved the plan and voted new bonds the state would sell its bonds to cover the refunding issue of the district. The measure was actively backed by the irrigation district association, but apparently, the metropolitan voters did not see the need for state aid to the irrigationists without any corresponding form of tax relief for themselves. Defeat of this measure leaves irrigation district refinancing in California up to the individual districts with such help as they may secure from the Federal government.

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## New Jersey Highways Reorganized to Make Saving

A reorganization program has been adopted by the New Jersey State Highway Commission, which is expected to effect an annual saving of $818,687. The program involves abolishing 388 positions, 33 per cent salary reductions and the elimination of division and branch offices.

Engineering offices at Camden, Newark and Jersey City will be abolished. The right-of-way and legal divisions will be discontinued.

The pay cut schedule is superimposed on an existing one of 10 per cent. Employees receiving more than $200 a month will be reduced 10 per cent additional; 7 per cent between $150 and $200; and 5 per cent between $100 and $150.

About one-half of the total estimated saving will be made in the engineering division.

## Bridge to Be Built Over Boeuf River

Plans for a highway bridge to span the Boeuf River, at Mason, near Fort Necessity, La., have been completed by the Louisiana Highway Commission and submitted to the United States district engineer at Vicksburg, Miss., for approval. The span meets the requirements approved by the Secretary of War on May 21, 1931. The plan for the structure provides for one steel swing span 160 ft. long, and two fixed steel spans each 140 ft. long. The swing span opening will have a horizontal clearance of 60 ft. and a vertical clearance of 36.5 ft. above low water and 11 ft. above high water. The total length of the bridge exclusive of the pile trestle approaches will be 440 ft.

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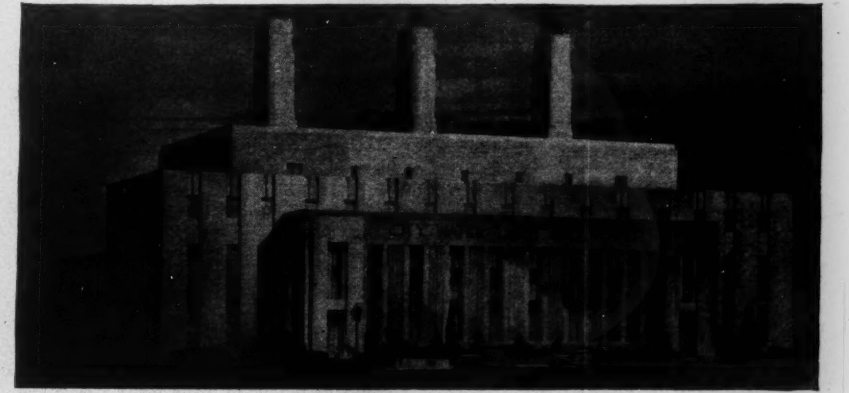
## Washington Engineering Work Taken Over by Col. Woodruff

Announcement has been made that Lieut. Col. Ulysses S. Grant, 3d, relinquished his post as director of public buildings and parks of the national capital to Col. James A. Woodruff, recently assistant commandant, general staff school, Leavenworth. Colonel Grant has been in charge of engineering work in connection with public buildings and parks in the national capital for seven years. The Arlington Memorial Bridge was built under his direction, also the World War Women's Memorial Building, the Red Cross office building and the new terminal warehouses. From the Washington work he now goes to a war college.

Colonel Woodruff is a graduate of West Point in the class of 1899. In the World War he organized and commanded the 10th Forestry Engineers.

Recently Major E. H. Gillette was assigned as assistant director of the office of public buildings and parks in addition to his duties as assistant executive officer of the Arlington Memorial Bridge Commission and as engineer of the National Capital Park and Planning Commission.



NEW WATER AND POWER PLANT FOR SPRINGFIELD, ILL.

**Construction of the first unit of a power plant for the city water, light and power department of Springfield, Ill., was approved recently by the city council. Included in the work to be undertaken at present is about half of the building here shown, covering an area 95x149 ft. It will cost about $150,000. The new plant will be near the Lake Springfield Dam, now under construction, and will house steam generating equipment, electric generators and water pumping equipment. The plant was designed by Burns & McDonnell, consulting engineers, Kansas City. Charles Meyer, Springfield, is architect for the building.**

## New York Approves Plan for Housing Development

The plan submitted by Sloan & Robertson, architects of New York City, for a housing development to utilize the Chrystie-Forsyth Street area owned by the city, has been approved by the New York City Board of Estimate and a lease of the area to Mr. Sloan and his associates has been authorized. The lease is conditioned upon the approval of the project by the State Housing Board and the obtaining of a federal loan.

Exclusive of land cost, the development is estimated to cost $9,289,708. The financial plan contemplates a federal loan of $8,360,737. The builder is to furnish $439,708.

All of the buildings on the seven blocks of city-owned land are to be 12 stories in height. There are to be 44 one-room, 329 two-room, 848 three-room, 353 four-room and 153 five-room apartments, or a total of 1,927. Average rentals are estimated to be $10.75 per room per month.

## Surety Responsible for Claims of Subcontractors

The Supreme Court of Pennsylvania on June 30 handed down a decision holding that the Great American Indemnity Co. is liable under the bond which it gave to the Commonwealth of Pennsylvania for the payment of claims of subcontractors.

In October of 1930 a fire did substantial damage to South Office Building No. 2 at Harrisburg. The Supreme Court in due course held that the contractor was obligated to restore this fire damage without additional expense to the state. As a result of this decision the Nelson-Pedley Construction Co., Inc., went into receivership and the subcontractors sued the Great American Indemnity Co. under the bond which was not only a construction bond but contained a clause conditioned for the payment of labor and material claims. Prior to this decision the courts in Pennsylvania had held that subcontractors did not have the right to sue on such a bond but could sue on a separate bond for their protection in case such a bond was taken.

The court, in the opinion just filed, pointed out that 45 states now hold that subcontractors may recover under such a bond and decided that Pennsylvania should no longer be an exception to the general rule. The claims of unpaid subcontractors totaled approximately $700,000.

## Trade Recovery Committee Ends Headquarters Activities

In view of the attainment of its essential objective through passage of the National Industrial Recovery Act with provision for a $3,300,000,000 public-works program, the National Committee for Trade Recovery on June 30 ended its headquarters activities and closed its New York office. Its state committees will continue to function in assisting the development of local projects and the progress of the necessary legislative and administrative steps to carry them forward to construction.

According to a report by Robert D. Kohn, chairman, and J. P. H. Perry, vice-chairman, submitted to the Construction League on June 30, the committee was formed early in 1930, when the unemployment emergency was rapidly growing to critical proportions, to secure the passage of federal laws by which federal credit might be applied in assisting normal necessary public works to be put under way for relief of unemployment and assistance in the recovery of industry and business, and to educate the public to adequate understanding of the purpose of these laws, so that they could be made effective promptly. The work was done at a cost of $21,000 for headquarters operations and about $50,000 for the activities of the state committees.

Compilations of deferred and needed public improvements prepared by the committee, showing a total of $3,289,000,000 of projects, were of important service in determining the form of the public-works section of the Recovery Act. The efforts of the committee resulted in the passage of laws by twenty states permitting service-charge financing of water-supply and sewerage facilities. Through the activities of the state organizations the completion of plans for local projects and their financial authorization were speeded up in preparation for construction under the public-works act.

## No Bids on Seattle Improvement Because of Rapid Price Rise

Despite the fact that $600,000 derived from the sale of the general fund bonds is in the bank and at least $450,000 of the $600,000 worth of local improvement district bonds were practically assured of acceptance, no bids were received by the Seattle board of public works on Wednesday, June 22, for the projected $1,200,000 Railroad Avenue improvement involving seawall, paving, etc. Difficulty of contractors in obtaining fixed prices for certain materials in view of rising rices on a project that will require two years to complete is given as the reason for the lack of bids. City Engineer M. O. Sylliaasen is quoted as saying: "I am told that with the government's Industrial Recovery Act now in effect, with wage increases, the regulation of hours of work, limitation of shifts, regulation of profits and the many factors entering into industrial control, the picture is changing each week and what would be a fair price today might be a bad bargain two years hence. Contractors were reluctant to submit bids under such conditions."

# National Conference on Slum Clearance Held in Cleveland Last Week

A national conference on slum clearance gathered 400 strong at the Hotel Cleveland on July 6 and 7 to listen to national housing experts, and to formulate—under the spur of prospective federal aid—housing plans of long-range, community-wide and nation-wide calibre. In unanimous approval of ten resolutions presented by a committee representing all sections of the country, headed by Daniel E. Morgan, one-time Cleveland city manager, and including such well-known figures as Alfred Bettman, Cincinnati, chairman of the National Conference on City Planning; John Nolen of Harvard; Charles F. Lewis of the Buhl Foundation, Pittsburgh; Dr. Ernest Fisher of the University of Michigan; H. M. Buttenheim, New York, editor, *The American City;* Bleecker Marquette of the Cincinnati Housing League; and Dr. Edith Elmer Wood of Columbia University, New York, the conference went on record as frankly recognizing that housing for the lowest income groups cannot be provided without government subsidy, cited the removal of existing social and economic conditions in slum areas as one of the most pressing of present-day problems, and called upon federal authorities to allocate to low-cost housing and slum clearance projects a very substantial portion of the $3,300,000,000 provided in the national recovery act.

The conference asked all city councils and administrations as well as state housing groups to aid and to participate in large-scale, low cost housing developments to the full extent of their legal and financial powers and urged specifically that the Public Works Administrator, in allocating and supervising the expenditure of housing funds, appoint associates chosen for their technical skill and experience and without regard for party affiliations.

The conference came out forcefully with a recommendation that all projects on which government aid is sought be ultimately self-liquidating; that the Administrator be assured in every instance that adequate provision had been made for continuous, responsible and experienced management. "Speculative profit should not be countenanced in any housing project," the report of the committee continued, "and no extortionate prices should be paid for land. While the power of eminent domain is highly desirable for low cost housing, we realize that recourse to such procedure is likely to involve delays possibly fatal to some projects. In this emergency, it is our belief that public opinion can be and should be aroused to impress owners of land with their duty to accept fair prices for their properties as set by qualified, disinterested appraisers."

Proper rehousing of slum residents during the period of new construction should be observed, the conference report said. Great care should be exercised, too, that model housing construction should not force former residents into other slum areas.

Legislatures which have not adopted housing laws were urged to do so. And where sufficiently low cost housing cannot otherwise be obtained, the formation of non-political state or local public housing authorities eligible to receive federal grants as well as loans was specifically recommended. The conference indorsed, too, the provision in the National Industrial Recovery Act for subsistence homesteads as an effective means of dealing with certain phases of housing related closely to the problems of unemployment and relief.

Foundations, other agencies, and individuals, were urged to donate funds for the establishing of research institutes in housing, and a committee of five was named by the conference chairman, Louis Brownlow, to forward this idea, upon adjournment of the two-day sessions. The committee is composed of Layton E. Carter, Director of the Cleveland Foundation, Donald Slessinger, Dean of Social Sciences, University of Chicago, Dr. Wood, Dr. Nolen and Mr. Marquette.

### Federal housing loans

While much of the program of the two-day meeting was given to the social and economic aspects of slum clearance and rehousing, a high spot of the conference was the detailed explanation of the National Recovery Act's housing provisions by A. Mackay Smith, of the legal division of the R.F.C. Pointing out that the act proposes that existing undesirable housing be replaced with projects that do not increase the density of population, Mr. Smith indicated that the housing administrator will prefer projects for those lower income groups to whom modern sanitary housing is not now available. Rents and dividends must be limited and the corporations receiving federal funds must give evidence of being permanent. For the purpose of making applications for loans an interest rate of 4 per cent may be assumed, but this is subject to change.

"New housing," continued Mr. Smith, "should not be confined to crowded centers, but should also include sections where land prices are such as to make housing for the lowest income people possible. Projects involving a low land cost will be preferred, since the purpose of the act is to provide employment. Land costs will be determined on the theory that housing is the best use that can be made of the land in question. Land coverage in proportion to building should not exceed 45 per cent.

"Buildings should be simple in design, but well constructed to insure low maintenance cost. Provision must be made for maximum light and air and for outdoor garden settings. Existing streets and utilities should be used insofar as possible. Preference should be given to fireproof construction. Stores in the correct proportion may be included in any project. An amortization period of 35 years on fireproof and of 25 years on non-fireproof buildings has been suggested. Equity investment may be furnished in the form of cash, land, materials, services or labor."

Ralph Borsodi, consulting economist and author of the Dayton, Ohio, project of cityedge, self-supporting homestead units, declared the clearing away of slum buildings and their replacement by model housing units would not alone solve the situation. In his own formula, embodied in the Dayton plan, it is planned to (1) condemn all slum property, (2) tear down the old and dilapidated buildings, (3) cover the area with city parks, (4) move slum dwellers to homesteads at the outskirts of the city, and (5) organize them to work in providing their own food and maintaining their own "cottage" type of home and large community homestead building. Dayton now has 12 such self-supporting units.

Dr. Edith Elmer Wood, of Columbia University, N. Y., in her paper on the "What? Why? and How? of Slum Clearance" defined a slum district as an area containing obsolete housing bad enough to have an adverse influence on the health and family life of its residents; characterized by a lack of modern improvements and long neglect of repairs; congested on the land and within the houses; lacking proper play space for children and adults, and in most cases with a mixture of uses, residential, commercial and industrial, none of them in a healthy condition. She cited current progress in Great Britain and Holland, two countries that have had slum clearance programs in operation for a number of years.

Alfred Bettman of Cincinnati, president, National Conference on City Planning, stressed that any general replanning of a slum area should be done by or through or under the direction of or, at the least, should be subject to the careful study and approval of, the official planning commission of the city. Howard W. Green, supervisor, Sixth District of Ohio 1930 Census, and director of the Cleveland real property inventory, demonstrated, with the aid of charts, the basic factors involved in slum clearance. He brought out the inescapable relationships between slum housing conditions and the prevalence of crime, juvenile delinquency, disease, and immorality. Land costs were discussed by Eugene H. Klaber of Chicago, chairman, committee on economics of site planning and housing, American Institute of Architects, who demonstrated an analytical approach to the problem which separated building charges from land charges, with the latter the last—rather than the first—item to be settled. Exaggerated land prices must be avoided. Blighted areas are bankrupt areas, he pointed out. And in liquidating a bankruptcy no one gets 100 cents on the dollar—nor expects to. The equity owner and the mortgagee must both face a loss and the community as well, for its assessments have been pegged on a supposed value that does not exist in fact. Appleton P. Clark, Jr., president, Washington Sanitary Housing Corp., described how the alley slums of the capital city have been 75 per cent cleared in a period of about 20 years.

## Harvard to Give Course in National Planning

A new course in "national planning" will be one of the features of next year's curriculum at Harvard University. The course, sponsored by the Harvard School of City Planning, is designed to acquaint students with the changing social and economic needs of American life, and to show the importance of long range planning in the physical development of the nation.

The immediate significance of national planning will be shown in the need for well conceived public works projects for relief of unemployment in times of depression.

The course is intended for students in the School of City Planning, but it will also be open under certain restrictions to students in other graduate departments of the University, such as the Schools of Architecture, Landscape Architecture, Engineering, or Business Administration. The course will be given during the second half of the academic year 1933-34 under the direction of Assistant Professor Arthur C. Comey, with lectures by other members of the City Planning staff, and experts from outside the University. The program for the course includes among many other subjects a study of the distribution of population, raw materials, public lands, and transportation systems in the United States, together with an investigation of effective methods for state and national planning.

## Emergency Bonds Authorized for Cleveland Sewage Plant

Issuance of $6,500,000 in bonds with which to finance completion of the easterly sewage disposal plant in Cleveland has been authorized by the State Welfare Department and Governor White. The authorization to issue the bonds in excess of the city's bond limitations was made possible by the state health director who declared that an emergency exists and that the work must be completed. The governor signed the emergency order immediately.

Resumption of work on the plant depends, however, upon the sale of the bonds. Work on the $12,000,000 project was stopped several months ago.

The $6,500,000 figure includes $2,000,000 with which to improve the westerly sewage disposal plant.

## New York Asks More Time to Build Incinerators

Delay until April, 1934 in the order of the United States Supreme Court to build garbage incinerators has been requested by New York City at a hearing before Special Master Edward K. Campbell. The order of the court in its present form required the city to have completed the construction of the garbage incinerators by June 30, 1933, to allow discontinuing the practice of dumping garbage at sea. The hearings now under way followed a complaint by the State of New Jersey that New York had not followed the order of the court.

In defense the city has offered its acute financial crisis which prevailed in March, 1932. Conditions at that time resulted in the indefinite delay of all construction projects, resulting from the city's inability to float a long-term bond issue.

## Court Holds Tacoma Responsible For Damage Caused by Pollution

Damages resulting from the contamination of the water supply of a fish hatchery may be collected from the city of Tacoma, Wash., according to a decision rendered recently by the supreme court of the state of Washington in an appeal taken by the city from the decision of a lower court.

The original suit was brought by the owner of a fish hatchery located about a quarter of a mile south of the city of Tacoma on Fleet Creek, who claimed to have suffered material loss through the death of fish believed to have been poisoned by the contamination of the creek by the city. The city was found to be discharging excess sewage from its sanitary system through a storm sewer into the swamp in which the creek rose at times of peak load on the sanitary sewer; also to be maintaining a garbage dump in the swamp.

The city opposed the suit on the ground, among others, that it had not been established that the death of the fish was due to the polluted condition of the water. However, the court ruled that there was sufficient evidence to support that conclusion and further that there was no question as to the pollution of the stream. The city, the court said, is not free to continue the maintenance of a nuisance.

## New Laws for Illinois Have Engineering Significance

Many of the laws passed by the Illinois State legislature during the session just completed are of import to engineers. Brief mention of some of the more important measures follows:

From the road fund (licenses) $68,500,000 was appropriated for hard roads. Likewise $49,000,000 was appropriated from the gas tax fund. These sums are for the biennium.

For a Chicago terminal for the Illinois Waterway $200,000 was provided, the funds to be furnished by the Santa Fe and Illinois Central railroads as final payment involved in an adjustment of lands for right of way. Plans are ready and bids will soon be asked.

The Sanitary District of Chicago was authorized to issue an additional $100,000,000 in bonds without referendum, a sum sufficient to complete the treatment program by 1938 in accordance with the decree of the Supreme Court.

The courts are permitted to extend the time for paying local assessments and to refund securities and interest issued in anticipation of collection of assessments.

County surveyors heretofore elected are now to be appointed.

Cities and counties may levy poor relief tax without limitation. County bonds already issued for unemployment relief are validated.

On referendum, consolidation of the three major park systems of Chicago and nineteen smaller ones may be effected, reducing expenditures an estimated 10 to 15 per cent. This is the first step in reduction of the numerous separate taxing bodies in Cook County in accordance with the Griffenhagen report. (See *ENR*, Dec. 8, 1932, p. 697.)

Distribution of a 3-cent gas tax is equally to cities, counties and the state, whereas formerly the state got 2 cents, the counties 1 cent and the cities nothing. This law follows the recommendations in this and several other respects of the report of the commission on future road program. (See *ENR*, Feb. 23, p. 256.)

A 2 per cent retail sales tax law was enacted, the proceeds to be used for unemployment relief until Jan. 1, 1934 when the proceeds may be used to replace state taxes on real estate.

A law already successfully operating and bringing in large sums from taxpayers authorizes the appointment of receivers for properties six months delinquent in payment of taxes. Every day from 50 to 75 receivers are being appointed.

To stop the depletion and diversion of the motor fuel fund a law prohibits the purchase of tax anticipation notes with such monies.

The powers of the Utilities Commission have been extended permitting it to set rates and then require the utilities at their own expense to prove they are not equitable.

After bids on cement had been rejected as excessive the state with the approval of the governor was authorized to buy cement without bids in the open market at not to exceed 90 per cent of the last bid prices.

Of special interest to municipal engineers are two bills that permit the issuance of bonds without referendum by cities to build sewers and disposal systems, bond interest and amortization to be paid by service charges as water revenue bonds are now serviced.

A limited-dividend-housing corporation act permits Illinois to take advantage of the housing provisions of the National Industrial Recovery Act.

## H. M. Waite Named a Deputy to Public Works Administrator

Henry M. Waite, former chief engineer of the Cincinnati Union Terminal Co. was named deputy administrator of public works under Title II of the Recovery Act, on July 11, as noted briefly on p. 56. For some time past Col. Waite has served unofficially as one of the staff named by Hugh S. Johnson to organize the public works administration and more recently he was named officially a member of the staff of the temporary administrator, Donald H. Sawyer.

Henry M. Waite

Col. Waite's early engineering experience was gained in 20 years of railroad work, following which he became chief engineer for the city of Cincinnati, serving as such from 1912 to 1914. In 1914 he became city manager of Dayton, Ohio, and remained there until he entered military service in 1918. During the war he served as a colonel in the Transportation Corps, first as a chief engineer of the corps, then as assistant deputy general of transportation, Second Army, and subsequently in the same position with the Third Army in Germany.

## Prevailing Wage Law in Texas

Predetermination of prevailing wages and their statement in contracts for all public works are required in a recent act of the Texas state legislature. The law applies to all public works performed under contract by the state or any political subdivision of the state. It applies to repair work under contract as well as to original construction. Exception is made of work performed by public utility companies on order by public authorities. Prevailing wage rates are to be determined by the public authority awarding the contract.

## New York State Makes Rules For Highway Work in Cities

Rules have been announced by the State of New York to govern the work to be done in cities from federal funds supplied under the highway-construction section of the National Industrial Recovery Act. These rules are based upon the rules and regulations issued by the Federal Public Works Board on June 23.

The work must be done by the State Department of Public Works and by contract.

No project can be considered unless the street to be improved is an extension of a Federal Aid highway.

The provision that "the reconstruction of existing facilities that are adequate for traffic shall not be considered needed improvements" is given interpretation. "Inadequacy" is interpreted to mean either a weak bridge or a too narrow pavement, or both. A city pavement through an outlying section not closely built up which has the same or greater width than the pavement of the Federal Aid highway adjoining it, is considered adequate in width. In closely built up sections of a city, a curbed pavement 14 ft. wider than the pavement of the Federal Aid road is considered adequate as to width.

No project less than $25,000 can be considered. Plans must be complete upon submission and rights-of-way secured or assured.

Projects received after July 25, 1933, will not be considered.

## SOCIETY CALENDAR

**AMERICAN ASSOCIATION OF ENGINEERS**, annual meeting, Chicago, Ill., Oct. 3-6, 1933.

**AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS**, annual meeting, Milwaukee, Wis., Oct. 9-11.

**AMERICAN INSTITUTE OF STEEL CONSTRUCTION**, annual meeting, Chicago, Oct. 17-21.

**AMERICAN PUBLIC HEALTH ASSOCIATION**, annual meeting, Indianapolis, Ind., Oct. 9-12.

**AMERICAN SOCIETY OF MUNICIPAL ENGINEERS**, annual meeting, Milwaukee, Wis., Sept. 25-27.

**AMERICAN WELDING SOCIETY**, fall meeting, Detroit, Mich., Oct. 2-6.

**HIGHWAY RESEARCH BOARD**, National Research Council, Washington, D. C., Dec. 7-8.

**INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS**, annual meeting, Milwaukee, Wis., Sept. 21-23.

**INTERNATIONAL CITY MANAGERS ASSOCIATION**, annual conference, International House, Chicago, Sept. 18-20.

**NATIONAL SAFETY COUNCIL**, 22nd Annual Safety Congress, Chicago, Oct. 2-6.

**NATIONAL ASSOCIATION OF RAILWAY AND UTILITIES COMMISSIONERS**, annual meeting, Cincinnati, Ohio, Oct. 10-12.

**NEW ENGLAND WATER WORKS ASSOCIATION**, annual convention, Bridgeport, Conn., Sept. 19-22.

**PENNSYLVANIA SEWAGE WORKS ASSOCIATION** will hold its seventh annual conference at State College, Pa., Sept. 5-7. The program that has been announced includes papers on "Operating Experiences in New York State," "Excessive Ground Water in a Sewer System and Its Effect on Sewage Plant Operation," "Application of the Sewer Rental Law," "Experiments Upon the Heating of Sludge to Determine the Heat Transfer Coefficient from a Heating Coil to Sludge," "Sewage Collection and Disposal at Lancaster, Pa.," "The Oxygen Demand Test and Its Application to Sewage Treatment," and "The Mechanical Dewatering of Sewage Sludge on Vacuum Filters."

## *Brief News*

**William Engineering Corp.** has been incorporated in Baltimore by Estelle William, A. David Gondorov and Samuel H. Gondorov, all of Baltimore.

**Allotment of Funds** by the Secretary of War for river and harbor improvement includes $1,164,000 for the South Atlantic Division, $5,088,500 for the Upper Mississippi Valley Division, $1,085,800 for the Great Lakes Division.

**A Tentative Practice Code** looking toward the establishment of a standard for maximum hours of employment and minimum rates of pay was presented to a mass meeting of general contractors of Southern California in Los Angeles on June 3.

**Surveys Have Been Commenced** on the proposed 200-mile Maniwaki-Abitibi highway in the province of Quebec. Construction of the road is contemplated as part of the winter program of relief work to undertaken by Quebec. Of the 200 miles there is already a good road for a distance of 90 miles, but further work will require breaking through an area now but little served with transportation facilities.

**The Pennsylvania Railroad** has ordered the Arundel Corporation, Baltimore, to resume work on the Hoffman street tunnel, one of the projects in the company's $22,000,000 improvement plan for Baltimore and vicinity that had been held up because of financial conditions. The railroad also has announced that the work of electrification of the system between Wilmington and Washington will be resumed immediately.

**A Considerable Amount of New Building** is being undertaken and planned in England, and this is generally regarded as a definite sign of the progressive national recovery of the country. Some important projects that were deferred some years ago because of economic conditions are now going forward. Among them is a new hospital center at Birmingham, intended to cover about 150 acres and to cost about two million pounds, now in the course of bidding. Another large hospital, to cost two hundred thousand pounds, is to be erected in Blackpool, and a group of exhibition buildings is to be constructed on a 5-acre site in Liverpool at a cost of three hundred thirty thousand pounds.

## *Obituary*

**R. D. Stewart**, who retired as chief engineer of the Denver & Salt Lake Railroad some years ago, died in Denver, Colo. June 28.

**Theodore G. Dickinson**, president, Marquette Portland Cement Co., which he founded 30 years ago, died in Chicago July 2 at the age of 77.

**William J. Berry**, the first city engineer of Beverly, Mass., died at his home in that place on July 6. He was born at Salem, Mass., eighty-four years ago, and made the first complete survey ever prepared for Beverly. He retired about twenty years ago.

**Foxhall Parker McCormick**, formerly president of the Parker-Washington Construction Co., died at his home in St. Louis, Mo., July 3 after several months illness. He was 68 years old. A native of Winchester, Va., he entered the construction business as a young man in New York City. Later he and his brother, David McCormick, established the Parker-Washington Co. in Kansas City. The firm moved to St. Louis about 1908 and was active until about six years ago when Mr. McCormick retired.

**Roy McLean Miller**, Toronto, well-known Canadian engineer, died suddenly from heart attack in Montreal on July 6. Mr. Miller, who was general manager of the firm of Roger Miller and Sons, Limited, Toronto, engineers and general contractors, was in his 49th year. He was born in Mount Elgin, Ont., and commenced his business career at Depot Harbor, Ont., becoming general superintendent of construction of Roger Miller and Sons when that concern was organized in 1909 at Sault Ste. Marie. In 1917 he was appointed plant manager of British Forgings, Limited, Toronto, but later rejoined his old firm, becoming president on the death of his father.

## *Personal Notes*

**Sidney A. Parsons**, senior civil engineer, in charge of specifications for the Massachusetts Department of Public Works, has recently been retired after 37 years of service.

**Joel D. Justin**, formerly hydro-electric engineer of the United Gas Improvement Company, has opened an office for the practice of his profession at 246 South Fifteenth Street, Philadelphia, Pa.

**C. H. Bowman**, state highway engineer of Wyoming, resigned July 1 after having held the office only two weeks. James B. True, state engineer, was appointed to fill out the unexpired term. Ill health was given as the reason for Mr. Bowman's resignation.

**Llewellyn Evans**, superintendent of the municipal light department of Tacoma, Wash., has accepted a position of consulting technician for development of the Muscle Shoals project. The offer covers a period of from three to six months. Evans has been granted the necessary leave of absence from the Tacoma department.

## Contracts and Capital

### CONSTRUCTION

(Thousands of Dollars)

| | Weekly July 1932 | Average Four Weeks | Week July 13 1933 |
|---|---|---|---|
| Federal Government.. | $11,176 | $756 | $1,650 |
| State and municipal... | 11,949 | 9,255 | 7,511 |
| Total public....... | $23,125 | $10,011 | $9,161 |
| Total private...... | 6,989 | 8,888 | 5,715 |
| Week's total....... | $30,114 | $18,899 | $14,876 |
| Cumulative to date: | | | |
| 1932................ | | $658,344 | |
| 1933................ | | 469,017 | |

### NEW PRODUCTIVE CAPITAL

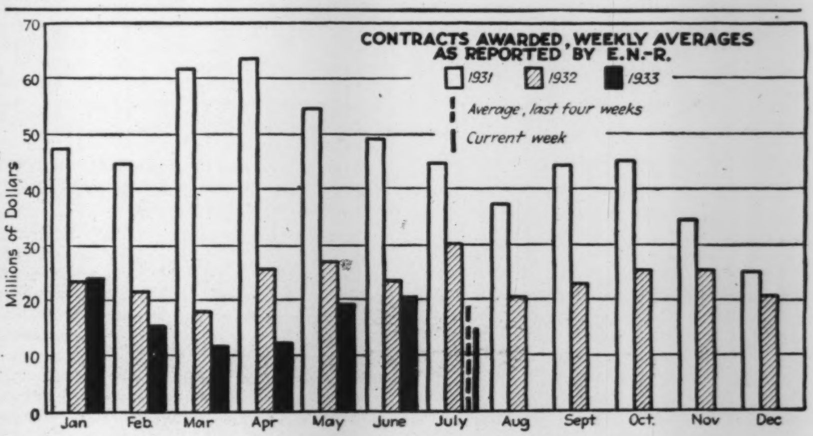
(Thousands of Dollars)

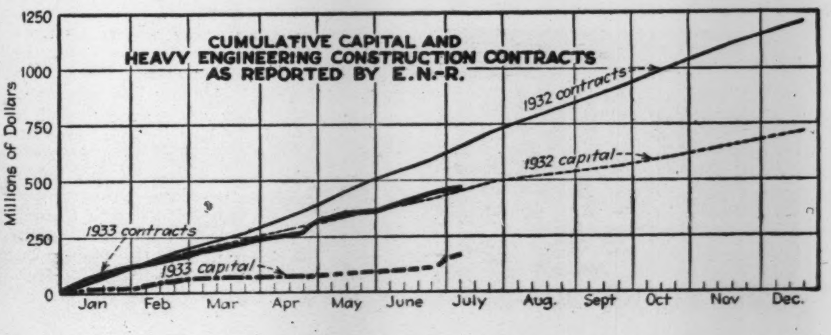
| | Weekly July 1932 | Average Four Weeks | Week July 8 1933 |
|---|---|---|---|
| New capital issues.... | $19,000 | $12,159 | $1,697 |
| Cumulative to date: | | | |
| 1932................ | | $439,000 | |
| 1933................ | | 171,453 | |

## *ENR* Cost and Volume Index

| **E.N.-R. Cost** | | **E.N.-R. Volume** | |
|---|---|---|---|
| **July, 1933.....** | **165.50** | **June, 1933.......** | **109** |
| June, 1933 ..... | 163.41 | May, 1933........ | 103 |
| July, 1932...... | 153.36 | June, 1932........ | 131 |
| 1932 (Average).. | 156.97 | 1932 (Average).... | 127 |
| 1931 (Average).. | 181.35 | 1931 (Average).... | 220 |
| 1930 (Average).. | 202.35 | 1930 (Average).... | 260 |

1913 Average.......... 100

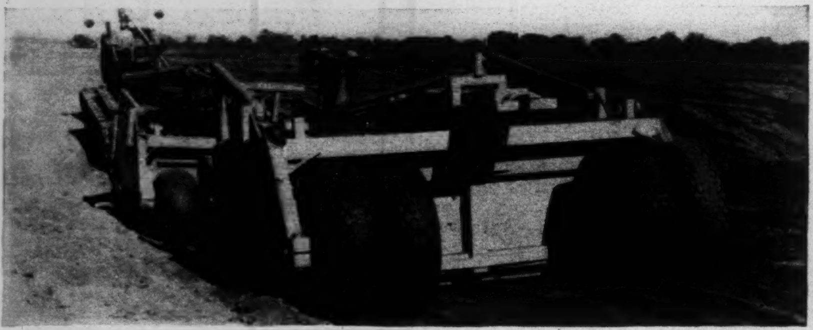




# *Construction Equipment and Materials*

## Cable-Controlled Scrapers For Tandem Operation

Handling two cable-controlled 11-yard scrapers behind a single tractor, both scrapers operated by the tractor operator, is made possible by the new Four Drum Power Control just placed on the market by R. G. Le Tourneau, Inc., of Stockton, Calif. The combination has a turning radius of 30 ft. The scraper is provided with pneumatic tires.


Four drum power control for large-capacity scraper operation.

The control unit is handled by means of levers. One lever controls each drum; thrown into one position it engages a clutch and causes the drum to wind up the cable; thrown into the other position, it releases the drum and allows the cable to run out; when the lever is released an automatic brake locks the drum into position. Two drums are used for each scraper, one to lower the scraper bowl for loading and raise it for hauling, the other to operate the unloading gate.

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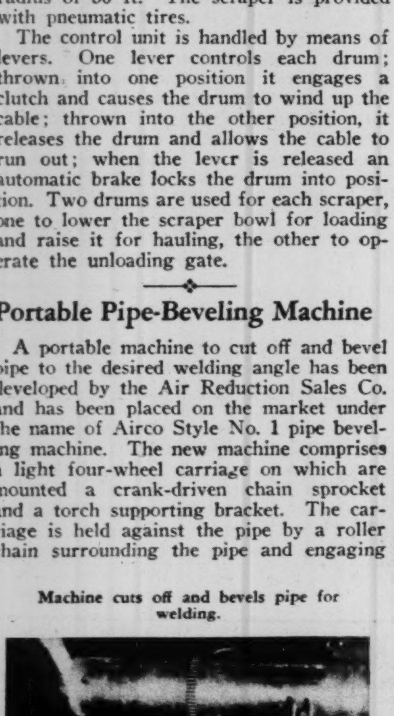
## Portable Pipe-Beveling Machine

A portable machine to cut off and bevel pipe to the desired welding angle has been developed by the Air Reduction Sales Co. and has been placed on the market under the name of Airco Style No. 1 pipe beveling machine. The new machine comprises a light four-wheel carriage on which are mounted a crank-driven chain sprocket and a torch supporting bracket. The carriage is held against the pipe by a roller chain surrounding the pipe and engaging the sprocket. The latter supported by coil springs reacts on the chain and when turned by the hand crank develops sufficient frictional grip to rotate the pipe when the latter is free to turn, or to rotate the machine itself around the pipe when the pipe is fixed in position.

The cutting torch is adjustable on the bracket to any required bevel angle from vertical for cutting off square to 45 deg.

Machine cuts off and bevels pipe for welding.



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### *New Equipment in Brief*

*Air Brush.* Eclipse Air Brush Co., Inc., Newark, N. J., announces its new G-6 gun of simplified design. The advantages claimed for the new spray gun are an accessible fluid plunger packing chamber, greater capacity, and increased flexibility.

*X-ray Paper.* St. John X-Ray Service Corp., 505 Fifth Avenue, New York, N. Y., announces an X-ray paper for industrial use which is claimed to have many advantages over celluloid film. It is low in price, easy to handle, fast-drying and requires only one intensifying screen. Two sheets are exposed simultaneously in one cassette, which has the advantage that one negative can be retained while the other goes along with the material.

*Portable Compressor.* The Sullivan Machinery Co., Chicago, Ill., has placed on the market a portable air compressor providing 505 cu.ft. displacement against the customary working pressure of 100 lb. per sq.in. The unit is a two-stage, four-cylinder compressor, powered by a six-cylinder Climax engine. The entire rig is mounted on a heavy fabricated steel-plate frame and mounted on steel wheels with rubber tires.

*Sewage Screens.* For the two new activated-sludge plants now under construction for the city of Lancaster, Pa., the Jeffrey Mfg. Co., Columbus, Ohio, has designed four self-cleaning bar screens of a new type. They are provided with a special hinged scraper which prevents jamming of the mechanism from the accumulation of foreign matter in the bottom of the channel or upon the screen proper. The teeth of the scraper, acting as a comb, pass entirely through the bars of the screens, cleaning not only the surface but the space between the bars, thus eliminating grease formation. The control mechanism is such that the screen may be operated continuously or at intervals of some 2 seconds to one hour.

*Air Compressor.* A complete line of rotary air compressors and vacuum pumps of the multi-cellular, sliding-vane type, in both water-cooled and air-cooled design is now made available by Allis-Chalmers Mfg. Co., Milwaukee, Wis. The line covers a range of volume from 50 to 2,000 cu.ft. per min. at pressures up to 150 lb. and vacuums up to 29.85 in. of mercury. The air-cooled units are suitable for pressures up to 10 lb. and vacuums up to 18 in. of mercury, and the water-cooled units for higher pressures and vacuums. The units operate at standard motor speeds.

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### *New Publications*

***Electric Weld Tubing.*** Republic Steel Corporation, Youngstown, Ohio, has issued a 68 page handbook of electric weld tubing. The company states that the handbook is an attempt to establish standards for the electric weld tubing industry. It has been drawn up and adopted by Steel & Tubes, Inc.

*Concrete Floors.* The Portland Cement Association, 33 West Grand Ave., Chicago, Ill., has issued two 4-page folders entitled "Concrete Floors for Industrial Buildings" and "Concrete Floors—How to Build Them". Cost, durability, cleanliness, safety, smoothness, solidity, comfort and maintenance are discussed, and correct construction methods explained.

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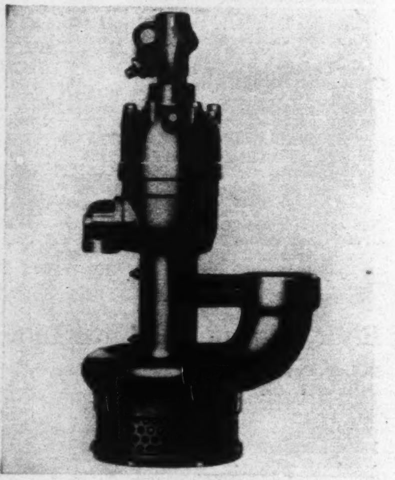
## Sump Pump Operated by Air Motor

A new portable, air-operated sump pump intended for use by mines, refineries, general contractors, public utility companies, and other fields of service has been developed by the Ingersoll-Rand Co., 11 Broadway, New York. It consists of an open-impeller type centrifugal pump driven by a multi-vane type air motor, both enclosed in a one-piece housing. The unit weighs 50 lb.

The pump is intended for lifts of 10 to 40 ft. with air pressures of 70 to 90 lb. Using air at 80 lb. pressure, the capacity ranges from 170 g.p.m. with 10-ft. lift through 20 ft. of 2½-in. hose to 125 g.p.m. with 40-ft. lift through 50 ft. of 2½-in. hose. The pump is self-priming as it has no suction lift, and must be submerged to cover the inlet screen.

Air-operated sump pump developed by Ingersoll-Rand Co.